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OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Volume XVII April-June 1983

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GENERIC CONCEPTS IN *DRECHSLERA, BIPOLARIS* AND *EXSEROHILUM*

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Abstract

Morphological and biological attributes of conidia have been used as taxonomic criteria at generic rank for *Drechslera, Bipolaris* and *Exserohilum*. These attributes were examined in the type species, *D. tritici-repentis, B. maydis* and *E. turcicum*. Constancy of the differences found was tested by determining the same characteristics for a range of species variously assigned among the three genera, and for a selection of unidentified isolates. It was concluded that recognition of three anamorph genera in this complex of species is justified and desirable. Nine new combinations in *Bipolaris* and one in *Exserohilum* are proposed.

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INTRODUCTION

Many fungi with dark phragmosporous conidia have been described in the genus *Helminthosporium*. Over 100 of these species were on members of the Poaceae (Gramineae). These graminicolous species cannot properly be included in *Helminthosporium*, and must be assigned elsewhere. There is divergence of opinion among mycologists and plant pathologists about the most appropriate genus or genera for these fungi. Shoemaker (1959, 1962), Simmons (1969), Leonard and Suggs (1974), Luttrell (1977, 1978) and others have claimed that three genera can be recognized, and that anamorph differences reflect great genetic differences as shown by the known teleomorph connections. Subramanian and Jain (1966) amended *Drechslera* to include all the graminicolous species, and this course has been followed by Ellis (1971, 1976), Chidambaram et al. (1973), Jooste (1975), Danquah (1975) and many other authors. The studies reported here were undertaken in an attempt to resolve these differences of opinion concerning generic limits in this important group of plant pathogens.

REVIEW OF LITERATURE

No attempt was made to segregate the graminicolous *Helminthosporium* species until Nisikado (1929a) erected the subgenera *Cylindro-Helminthosporium* and *Eu-Helminthosporium*. Into the former he grouped species such as *H. tritici-vulgaris* Nisik. with straight cylindrical conidia which germinate by one or more germ tubes from any cell. Species with fusiform and often curved conidia germinating only from the end cells were placed in *Eu-Helminthosporium*. The subgenus *Cylindro-Helminthosporium* was raised to generic rank as *Drechslera* by Ito (1930), who characterized members of the new genus as having 'cylindrical, not curved conidia, germinating from every cell and associated with *Pyrenophora*'. Ito did not nominate a type species, and Hughes (1958) selected *D. tritici-vulgaris* (Nisik.) Ito as the lectotype. Subsequently this name has been considered a synonym of *D. tritici-repentis* (Died.) Shoem. (Shoemaker 1962).

The genus *Bipolaris*, with *B. maydis* (Nisik. & Miyake) Shoem. as its type species, was erected by Shoemaker (1959) to accommodate members of the subgenus *Eu-Helminthosporium*. Conidia were described as fusoid, straight or curved, and germinating by one germ tube from each end. Subramanian and Jain (1966) considered characters such as conidium shape and germination to be sufficiently variable as to delineate an 'heirachy of differences in the graminicolous species'. They amended the description of *Drechslera* to include all species of *Helminthosporium* from grasses, including those previously disposed as *Bipolaris*.

Bipolaris as circumscribed by Shoemaker (1959) was heterogeneous. It included species such as *B. turcicum* (Pass.) Shoem. and *B. rostrata* (Drechsler) Shoem. in which the conidial hilum protrudes, and for which teleomorphs in *Trichometasphaeria* were known (Luttrell 1958). In contrast other *Bipolaris* species were known to have *Cochliobolus* ascal states (Drechsler 1934; Dastur 1942; Luttrell 1957). This heterogeneity was removed by the erection of the new genus *Exserohilum* for species with a protuberant hilum (Leonard & Suggs 1974). *E. turcicum* (Pass.) Leonard & Suggs was chosen as the type species. A new ascomycete genus, *Setosphaeria*, was described by Leonard and Suggs for *Bipolaris* teleomorphs previously placed in *Keissleriella* or *Trichometasphaeria*. Ellis (1971, 1976) accepted

Drechslera in the wide sense, and listed *Bipolaris* and *Exserohilum* as synonyms. Reasons for this action included difficulties associated with assigning many critical species (unspecified) to any of the three proposed genera, and the lack of knowledge of teleomorphs (Ellis 1976).

Bases for delimiting *Drechslera, Bipolaris* and *Exserohilum*

Drechslera and *Bipolaris* were differentiated essentially by two characters, namely conidium shape and germination pattern. Conidia are fusoid and germinate only from end cells in *Bipolaris,* while in *Drechslera* they are cylindrical and germinate from any cell (Ito 1930; Shoemaker 1959, 1962). Additional criteria for separating the two genera were suggested by Luttrell (1963a, 1964a), following a comparison of *Helminthosporium avenaceum* Curt. ex Cke. and *H. sorokinianum* Sacc. He drew attention to the variability in the point of origin and direction of growth of the germ tubes from end cells. In *H. avenaceum* the germ tube from the basal cell is lateral, originating well clear of the hilum and growing at a wide angle to the longitudinal axis of the conidium. The basal germ tube in *H. sorokinianum* is semiaxial, emerging close to the hilum and growing more or less in the direction of the long axis. Luttrell (1963a) also suggested that differences in conidium maturation might be used as a taxonomic character at generic rank. He noted that in developing conidia of *H. avenaceum*, the first-formed septum delimits the basal cell, while in *H. sorokinianum* it forms in a median position. Shoemaker (1966) endorsed Luttrell's assessment of generic characters in *Drechslera* and *Bipolaris*, and also noted that the nature of the conidial hilum provides useful information: it is a flat scar included in the contour of the basal cell in *Drechslera*, while in *Bipolaris* it protrudes slightly to prominantly. Subsequently Luttrell (1977) referred to conidium shape, colour, and type of germination as significant characters, but did not mention septum ontogeny. There is an absence of data on the last-named characteristic for most species (Luttrell 1964a), and this may have led to its deletion as a useful character. However it was used subsequently as a character in a key to genera (Luttrell 1978). Attention was focused on the hilum as a generic characteristic by the action of Leonard and Suggs (1974), who erected the genus *Exserohilum* for species in which the conidial hilum protrudes. They differentiated between a 'truly protruding' hilum, present in the species accepted, and exsertion of the conidial wall to give the appearance of a protruding hilum. The latter condition was reported to apply in conidia of *H. micropus* Drechsler.

One of the factors contributing to the uncertainties about generic taxonomy in this group of fungi is undoubtedly the lack of experimental evidence in support of one or other of the following possibilities: to unite all species in one genus, or divide them among three genera. I have attempted to remedy this deficiency with the results presented in the remainder of this paper.

MATERIALS AND METHODS

The morphological and biological attributes of conidia which have been proposed as generic characteristics were examined in the type species of *Drechslera*, *Bipolaris*, and *Exserohilum*, and in a range of other species and isolates variously assigned among these genera. Where possible, the isolates used were compared with type specimens or other authentic material to ensure that specific epithets were correctly applied. In some instances cultures from the type collection were available, or were supplied by the author of the name. Collection data for isolates used in tests of generic characteristics are provided in the appendix.

Authentic specimens of the type species

Hughes (1958) selected *Drechslera tritici-vulgaris* as the lectotype species for *Drechslera*. Subsequently this name was put into synonymy with *D. tritici-repentis* (Shoemaker 1962). It is clear from the papers by Hughes (1958) and Shoemaker (1962) that neither author saw authentic material of *D. tritici-vulgaris* or *D. tritici-repentis*. The Nisikado collections are now housed in the Mori Mushroom Research Institute, Japan, and I was able to borrow a specimen of *Helminthosporium tritici-vulgaris* from that institution. Unfortunately no conidia of this fungus could be found on the material. In contrast, a specimen of *H. tritici-repentis* (Died.) Died. from the herbarium of H. Diedicke (in JE) was found to have conidiophores and conidia present. It was concluded that the isolates used in the experiments described later in this paper were correctly assigned to *D. tritici-repentis*. The description and illustrations of *H. tritici-vulgaris* by Nisikado (1929b) leave little doubt that his species is conspecific with *D. tritici-repentis*. Nisikado differentiated his fungus principally on the lack of constriction at the basal conidial septum, but this characteristic is variable (Shoemaker 1962) and unsuitable for species separation.

Authentic specimens of *H. maydis* Nisik. & Miyake were borrowed from the Mori Mushroom Research Institute. Examination of these collections confirmed that the isolates used in this investigation were correctly identified. A similar comparison was made for *H. turcicum* Pass., using an authentic specimen from the Passerini collections in PARMA.

A method for inducing sporulation in *D. tritici-repentis*

Unlike many other *Drechslera* species, *D. tritici-repentis* does not sporulate readily in culture. In preliminary tests to overcome this difficulty, cultures were grown on potato dextrose agar, V-8 juice agar (V-8A), potato carrot agar (PCA), and wheat straw on water agar (WSA). Cultures were exposed to continuous fluorescent light for five days followed by 24 hours darkness, after the method of Khan (1971). Similar cultures were exposed to near-u.v. on a 12 hour diurnal cycle at room temperature, ca. 24-26°C. Sporulation occurred most regularly on V-8A exposed to near-u.v., but was variable within and between tests and between isolates. In various tests it was noted that sporulation sometimes occurred on the block of agar culture used to inoculate plates, but not subsequently on the test medium. Booth (1971) referred to this method of inducing sporulation and attributed its efficacy to the removal of autotoxic staling substances from the agar block. The effect was utilized in the following method, which has been found useful for inducing sporulation in *D. tritici-repentis*. Many other species of *Drechslera* s.l. sporulate freely when treated in a similar manner.

(i) Isolates were cultured on V-8A in Petri dishes, exposed to near-u.v. at 24-26°C with a 12 hour photoperiod.
(ii) After five to seven days growth, aerial structures were removed from the cultures by scraping the colony surface with the flamed end of a microscope slide.

(iii) Discs were cut near the colony margin with a flamed cork borer, and the discs transferred to water agar in Petri dishes.

(iv) The water agar plates with V-8A discs were incubated in the dark at 15°C.

Conidiophores grew from the upper surface and from the sides of each disc, and after 24 hours each conidiophore bore a single mature conidium. In addition conidia were produced at 7°, 11°, and 19° but not at 22.5°C or higher, at which temperatures the discs produced only hyphae.

Platt et al. (1977) examined the effects of substrate, temperature, and photoperiod on conidial sporulation by *Pyrenophora tritici-repentis* (Died.) Drechsler. Sporulation was most abundant in cultures grown on V-8A at 21°C with a light period of 12 hours (4790 lux). They reported that conidia were produced at temperatures up to 25°C. Sporulation sometimes occurred in my cultures exposed to near-u.v. at 24-26°C, but not on discs from these plates subsequently incubated in the dark at these temperatures.

Methods for studying septum development in maturing conidia, and conidium germination

It was found impracticable to search for 1-septate conidia in normal plate cultures, and the method described above for inducing sporulation in *D. tritici-repentis* was also used for studies on primary* septum development. Advantages of the transferred-disc technique include more or less synchronous formation of the first conidium on each conidiophore, the ease of observation using transmitted light on a dissecting microscope, and the ease of preparation of slides by taking tangential slices from the side face of one or more discs. Commonly, V-8A discs on water agar were used for observations of septum development, and subsequently as sources of mature conidia for studies of germination. Discs were suspended in sterile distilled water and agitated thoroughly. The resulting suspension of conidia was incubated for 16 hours in the dark at 25°C, on microscope slides and on water agar in Petri dishes. Occasionally detached host leaves were used as additional substrates for germination.

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* Used here and subsequently in the sense of 'first-formed'.

MORPHOLOGICAL AND BIOLOGICAL ATTRIBUTES IN THE TYPE SPECIES OF *DRECHSLERA*, *BIPOLARIS* AND *EXSEROHILUM*

Various aspects of conidial morphology and biology in the generic types were examined, and the results of the examination of these species are presented first.

GERMINATION IN THE GENERIC TYPES

Drechslera tritici-repentis

Conidia of this species germinate from intermediate and polar cells (amphigenous germination sensu Luttrell 1963a), or predominantly from the polar cells only. There were statistically significant differences between germination substrates (more conidia germinate amphigenously on water agar or host leaves than on slides), and between conidia from different isolates incubated on the same substrate. In one test, amphigenous germination in conidia from six isolates incubated on water agar ranged from 0-32%.

Although the number and position of germinating cells varied widely, there was no corresponding deviation in the other characteristic observed. Basal germ tubes were usually lateral, arising at a point approximately midway between the hilum and the basal septum (Fig. 1), and growing at a wide angle to the long axis of the conidium (often at right angles). Very rarely, the basal germ tube arose close to the hilum and grew approximately in the direction of the long axis. Germ tubes from the apical cell were more variable, often occurring laterally but also emerging close to the apex of the cell and growing parallel with the long axis of the conidium.

Bipolaris maydis

Germination by conidia of this species is predominantly polar (Fig. 2). Amphigenous germination does occur, but only rarely in more than 3% of germinated conidia. On water agar or leaf of *Zea mays* L., bipolar germination occurs in ca. 90% of all conidia which germinate. In contrast, incubation on slides reduces the proportion of bipolar germination to ca. 50% while increasing the total monopolar germination correspondingly.

The germ tube from the basal cell in conidia of *B. maydis* originates adjacent to the hilum (Fig. 4), and grows in the direction of the long axis of the conidium (semiaxially sensu Luttrell 1963a). The emerging germ tube is often so close to the hilum that the hilum is displaced laterally. The germ tube from the apical cell arises at its tip, and grows more or less axially.

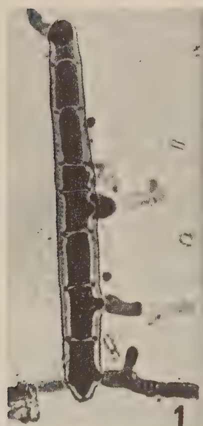
Exserohilum turcicum

Polar germination is also common for conidia of this species, often occurring in over 80% of spores. In some tests however, up to 13% amphigenous germination was recorded, with one or more intermediate cells producing germ tubes (Fig. 5). Amphigenous germination was generally greatest in conidia incubated on water agar.

The position at which the germ tube emerged from the basal cell was also more variable in this species than in *B. maydis*. Commonly, the germ tube was semiaxial and caused strong displacement of the hilum (Figs. 3,4). In various tests, up to 6% of basal germ tubes emerged well clear of the hilum and grew laterally (Fig. 6), in a manner similar to basal germ tubes of *D. tritici-repentis*.

Conclusions concerning conidium germination in the generic types

The number and position of germinating conidial cells are subject to considerable variation. Thus they are not, on their own, suitable criteria for delimiting genera as has been proposed (Ito 1930; Shoemaker 1959). One facet of germination does provide useful taxonomic information: the point of origin of the germ tube from the basal cell, and its direction of growth in relation to the long axis of the conidium. Clearly *Drechslera* is distinct from *Bipolaris* and *Exserohilum* in this characteristic as shown by the respective type species, whereas the last two genera are not. Thus, observations on the generic types have confirmed the assessments of Luttrell (1963a, 1964a, 1964b, 1977) and Shoemaker (1966) on the usefulness of this aspect of germination as a generic criterion.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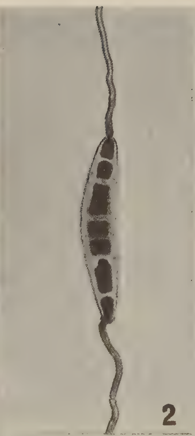
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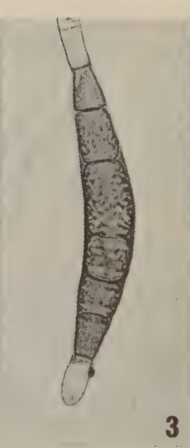
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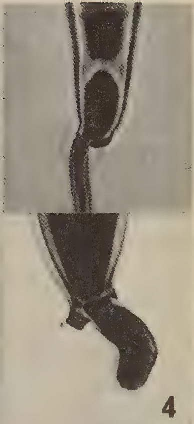
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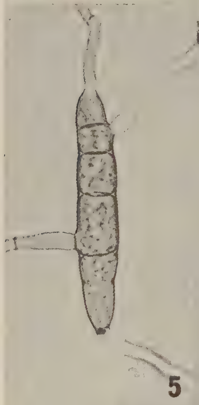
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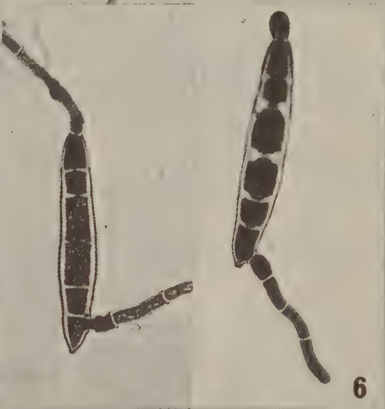
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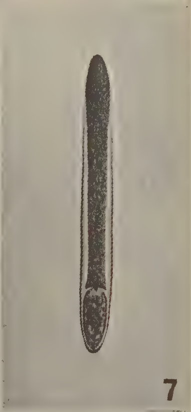
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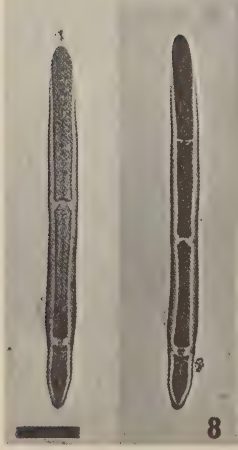
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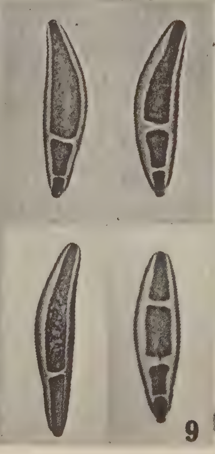
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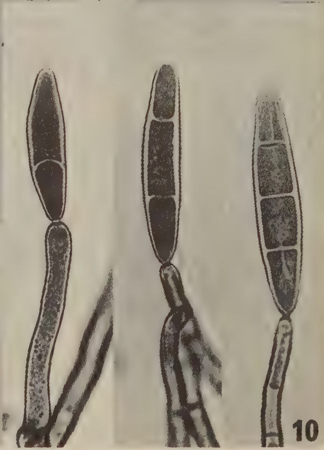
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ONTOGENY OF CONIDIAL SEPTA IN THE GENERIC TYPES

Unless otherwise stated the following results were obtained from conidia produced on V-8A discs supported on water agar, and incubated at 24-26°C. Once 1-septate conidia had been found, several slides were prepared to ensure that sufficient conidia at this stage of development would be available for examination and measurement. Fully developed conidia were taken from the same discs 1-2 days later.

The position of the first-formed septum in the developing conidium was usually unambiguous. If the septum formed near the base of the spore it proved to be that septum which, in the mature conidium, delimited the basal cell. On the other hand primary septa in an approximately median position did not delimit the basal cell. This characteristic is essentially qualitative, but I have provided some quantitative evidence by comparing measurements from 1-septate conidia and mature conidia. The data taken are explained below, and illustrated diagrammatically in Figure 11.

Parameter	Definition
a	the distance from the base of the conidium to the primary septum, in 1-septate conidia
a_1	the distance from the base of the conidium to the septum proximal to the base, in mature conidia

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Figs. 1-6 Germination in the generic types of *Drechslera, Bipolaris* and *Exserohilum* (1) *D. tritici-repentis,* amphigenous germination (2) *B. maydis,* bipolar germination (3) *E. turcicum,* bipolar germination with hilum strongly displaced (4) Detail of basal germ tube emergence in *B. maydis* (upper) and *E. turcicum* (lower) (5) *E. turcicum,* amphigenous germination (6) *E. turcicum,* lateral emergence of basal germ tube. Figs. 7-10 Septum ontogeny in the generic types (7) Primary septum in *D. tritici-repentis* (8) Conidia of *D. tritici-repentis* with 2 and 3 septa (9) Conidia of *B. maydis* with 1, 2, and 3 septa (10) Conidia of *E. turcicum* with 1, 2, and 3 septa. Scale represents 10 µm, fig. 4; 25 µm all other figures.

b	the length of 1-septate conidia
b_1	the length of mature conidia
s	the number of septa in each mature conidium measured to obtain the values for b_1
x	the number of the septum nearest the mean for a, counted from the base, in each mature conidium
b/a	quotient calculated from the means for a and b

For species in which young conidia reach mature size before developing septa (holosporous maturation fide Luttrell 1963a), there should be little difference between the values for b and b_1. If this condition applies in species where the primary septum delimits the basal cell, then a and a_1 also should be approximately equal. In species with a median first septum, the value for a_1 should be much lower than for a. For the latter type, the quotient b/a would be near 2. When the primary septum is basal, b/a would be greater than 2. The magnitude of the increase over 2 would be proportional to the length of the mature conidium. It would be much greater in species with long, many-septate conidia than in those with short conidia having few septa, because in the latter type the basal cell accounts for a proportionally greater fraction of the mature conidium length.

The results in Tables 1-4 are presented as means of 15 measurements for each parameter (a, a_1, b, and b_1 are in µm). In optical section the primary septum sometimes appeared pateriform, with the concavity directed towards either the proximal or distal extremity of the conidium. In such cases a was measured to the point where the septum joined the lateral wall.

Drechslera tritici-repentis

Numerical data on primary septum ontogeny in four isolates of *D. tritici-repentis* are presented in Table 1. Plates with discs of V-8A were incubated at three temperatures, 11°, 15°, and 19°C, and data for 1-septate conidia recorded after 19 hours. Mature conidia were examined after 48 hours at these temperatures.

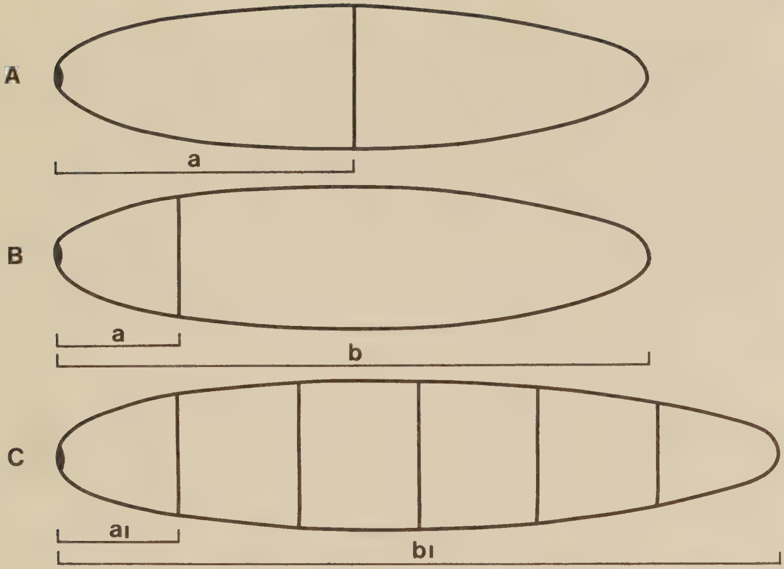


Fig. 11. Measurements taken from maturing and mature conidia in studies of septum ontogeny. In A the primary septum is median, and b/a = 2; in B the primary septum is near the base, and b/a = 5. For A maturing to C, x = 2-3; for B maturing to C, x = 1.

Table 1. Primary septum ontogeny in conidia of *Drechslera tritici-repentis* from different isolates

Isolate	Temp. °C	a	a_1	b	b_1	s	x	b/a
1511*	15	20.8	21.3	103.5	131.5	5.7	1.0	5.0
	19	22.1	23.8	107.8	150.3	5.6	1.0	4.9
21615	11	24.3	24.8	94.3	144.3	5.2	1.0	3.9
	15	22.5	23.3	94.5	135.3	6.1	1.0	4.2
	19	23.9	25.0	107.0	138.5	5.3	1.0	4.5
7818	11	24.1	25.8	98.0	145.8	5.0	1.0	4.1
	15	24.6	25.4	103.5	152.5	5.5	1.0	4.2
	19	24.3	25.5	115.3	156.5	5.6	1.0	4.7
7819	11	23.3	24.4	100.5	140.5	5.0	1.0	4.3
	15	20.8	23.9	102.3	144.8	5.2	1.0	4.9
	19	22.1	24.0	107.5	152.3	5.5	1.0	4.9

* No conidia formed at 11°.

Clearly the first-formed septum in conidia of this species delimits a cell basally which is not further divided, that is it becomes the basal cell in mature conidia (Fig. 7). There is a considerable increase in conidium length with maturation, but this is not accompanied by a corresponding increase in the length of the basal cell (Table 1). In 1-septate conidia, the lateral walls are thickened in the basal and median sections. The walls become thinner and paler towards the apex, and it is probably here that most growth occurs. The characteristic conic shape of the basal cell is defined early in conidial growth, prior to formation of the first septum.

Observations were also made on 2-septate and 3-septate conidia. The second septum forms in an approximately median position in the upper cell delimited by the primary septum. The third septum develops in the cell distal to the second septum (Fig. 8). The mean length of 3-septate conidia approximates that of mature spores, and possibly by the time the third septum forms the conidium has ceased longitudinal growth.

Field-collected conidia of *D. tritici-repentis* were examined, in addition to those formed in culture. A sample harvested by cyclone-collector from infected wheat plots contained many immature conidia, with 0-2 septa. The positions occupied by the first and second septa were similar to those in conidia from cultures.

Bipolaris maydis

This species sporulates freely at 24-26°C, and plates were incubated at these temperatures for examination of first septum development. The primary septum in conidia of *B. maydis* is submedian (Fig. 9), with *b/a* quotients ranging from 2.7 to 3.0 (Table 2). These results are in contrast with the observation by Luttrell (1964b) that the first-formed conidial septum in this species is median. It might be argued that *b/a* values greater than 2 could be obtained if the young conidium elongated in the apical portion after the first septum formed, but before samples were taken. The evidence does not favour this explanation. In some conidia the primary septum was very thin and only visible at high magnification (x400), whereas in others it was thicker and readily detected at low magnification (x100). It can be assumed that the thin septa are of recent origin. In 60 conidia from isolate 20239 with a thin primary septum just discernable, the *b/a* quotients ranged from 2.3 to 3.6. The numbers of conidia in each category were: 2.3(1), 2.4(2), 2.5(2), 2.6(4), 2.7(4), 2.8(4), 2.9(6), 3.0(8), 3.1(6), 3.2(7), 3.3(5), 3.4(8), 3.5(2), 3.6(1). In this and other isolates, conidia with a median primary septum (*b/a* = 2.0) were seen occasionally, but were much less frequent than conidia with the first septum distinctly submedian.

The second septum in maturing conidia of *B. maydis* forms near the base (Fig. 9). The distance from the base to this septum is approximately the same as the value for the parameter a_1, indicating that the second septum cuts off the basal cell. The third septum forms towards the apex of the conidium, cutting off a cell distally which may or may not be further divided (Fig. 9).

Table 2. Primary septum ontogeny in conidia of *Bipolaris maydis* from different isolates

Isolate	a	a_1	b	b_1	s	x	b/a
3824A	25.0	11.1	69.1	86.6	7.3	2.5	2.8
19629	23.3	9.1	68.3	81.0	7.3	2.5	2.9
19679	26.2	10.6	69.9	84.8	7.4	3.0	2.7
20239	23.8	10.7	71.5	75.9	7.4	2.8	3.0

One-septate conidia of *B. maydis* from infected leaves are similar to those from culture. Leaves of *Zea mays* were detached from plants two days after inoculation with conidia from isolate 20239, and leaf segments with lesions were incubated in Petri dish moist chambers. Values for the various parameters measured were similar to those for conidia from culture. The *b/a* quotient was 2.9.

Septum ontogeny in conidia of *D. tritici-repentis* and *B. maydis* was compared directly in cultures allowed to sporulate at 15°C. This was done to remove any doubt that *B. maydis* might develop conidial septa in a different position at the lower temperatures favouring sporulation by *D. tritici-repentis*. Results for each species were very similar to those reported above. The primary septum was submedian in conidia of *B. maydis* (b/a = 2.4-2.5) and in *D. tritici-repentis* delimited the basal cell of mature conidia.

Exserohilum turcicum

The primary septum in this species forms approximately one third of the total length from the base (Table 3). The next septum develops towards the apex, delimiting a distal cell more or less equal in length to the cell at the base. The third septum is approximately median in the conidium, equidistant between the first two septa (Fig. 10).

Table 3. Primary septum ontogeny in conidia of *Exserohilum turcicum* from different isolates

Isolate	a	a_1	b	b_1	s	x	b/a
77159	25.1	16.9	78.7	103.8	5.5	1.7	3.1
7333	24.7	17.9	72.1	110.1	6.2	1.4	2.9
6121	24.1	16.4	73.4	97.5	5.5	1.7	3.0

Occasionally the primary septum is formed in a median position. Similarly the second septum sometimes occupies this site when the primary septum is submedian. The basal segment cut off by the primary septum subsequently is divided into two cells. Numerical data for 2- and 3-septate conidia are given in Table 4. It can be seen by comparing measurements in Tables 3 and 4 that conidia continue to increase in length after each of the first three septa is formed.

Table 4. Development of the first, second, and third septum in conidia of *Exserohilum turcicum**

Conidium type	a	a_2	a_3	b	b/a	b/a_2	b/a_3
2-septate	26.6	65.6	-	89.8	3.4	1.4	-
3-septate	26.5	71.8	49.8	94.3	3.6	1.3	1.9

* From 2- and 3-septate conidia of isolate 77159, in the same preparations yielding data in Table 3. a_2 = second septum, a_3 = third septum.

Primary septum ontogeny in conidia of *E. turcicum* as determined by cultural methods is similar to that occurring in nature. Leach et al. (1977a) have published a photomicrograph of a 1-septate conidium of this species caught in a spore trap. The septum is in the lower half of the conidium, and the b/a quotient is 3.0. Subsequently the same authors have illustrated median primary septum development in the same species (Leach et al. 1977b). Luttrell (1964b) has also claimed that this type of development occurs in *E. turcicum*. My results are at variance with the reports of these authors.

Conclusions concerning conidial septum ontogeny in the generic types

Drechslera can be differentiated readily from *Bipolaris* and *Exserohilum* by a consideration of primary septum ontogeny. In the last two genera, the first conidial septum is commonly submedian but this character alone would not allow their separation. It is suggested that an additional taxonomic criterion is furnished by second and third septum development. The position in which the second septum forms is different for each of the type species. The third septum in conidia of *D. tritici-repentis* and *B. maydis* occupies an equivalent position in each, but the corresponding septum in *E. turcicum* occurs in a different position.

HILUM MORPHOLOGY IN THE GENERIC TYPES

As a preliminary to this investigation, the hilum in conidia from living cultures was compared with that in conidia from dried cultures and from host leaves which had been processed as herbarium specimens. There was no greater variation in hilum structure between different sources for a species than within conidia from a single source.

The term hilum is commonly applied to the mark or scar on a spore which indicates the point of attachment to a sporophore (Ainsworth et al. 1971; Snell & Dick 1971; Ellis 1976). In this paper, the hilum is defined as that part of a conidium which shows by differences in colour and/or morphology where it was attached to or in close proximity to the conidiophore during conidium maturation. This definition is purposely broad. It can be applied in descriptions of genera such as *Pseudocercospora*, where the base of the conidium is truncate but neither thickened nor darkened (Deighton 1976). In one large group of species within the *Drechslera* s.l. complex, the darkened elements of the hilum are completely within the spore wall and could hardly be termed a scar. The definition given above is applicable in these instances too. In addition, I make no distinction between wall layers. Conidia of *Drechslera* s.l. are distoseptate. They have a thin outer wall, and a thick inner wall which plays a part in septum formation. The outer wall can often be revealed only when conidia are crushed. In the context of describing hilum structure, the two walls are regarded as a single unit because of difficulties in distinguishing them in intact conidia. Various elements of the hilum are mentioned in the following descriptions. Unless stated otherwise, the structures are referred to as they appear in optical section. Observations were made on conidia mounted in lactophenol, using an oil immersion objective (x100) and x10 eyepieces.

Drechslera tritici-repentis

In this species the basal cell in the region of the hilum is rounded and has no projections or abrupt changes in contour. The hilum is inconspicuous, with the darkened area somewhat indefinite in extent (Fig. 12). A narrow basal pore is often visible in the cell wall, perforating the hilum and connecting the lumen of the cell to the exterior. There is sometimes a shallow concave identation where this pore opens to the exterior surface. The conidium wall is darkened around the pore. In optical section a very dark broad V-shaped pigmented region is visible in the wall, with the base of the V close to the base of the cell. The wall in close proximity to the deeply pigmented region is also darkened, but less intensely. In some conidia the heavily pigmented area is contiguous with either the inner face or the outer face of the wall.

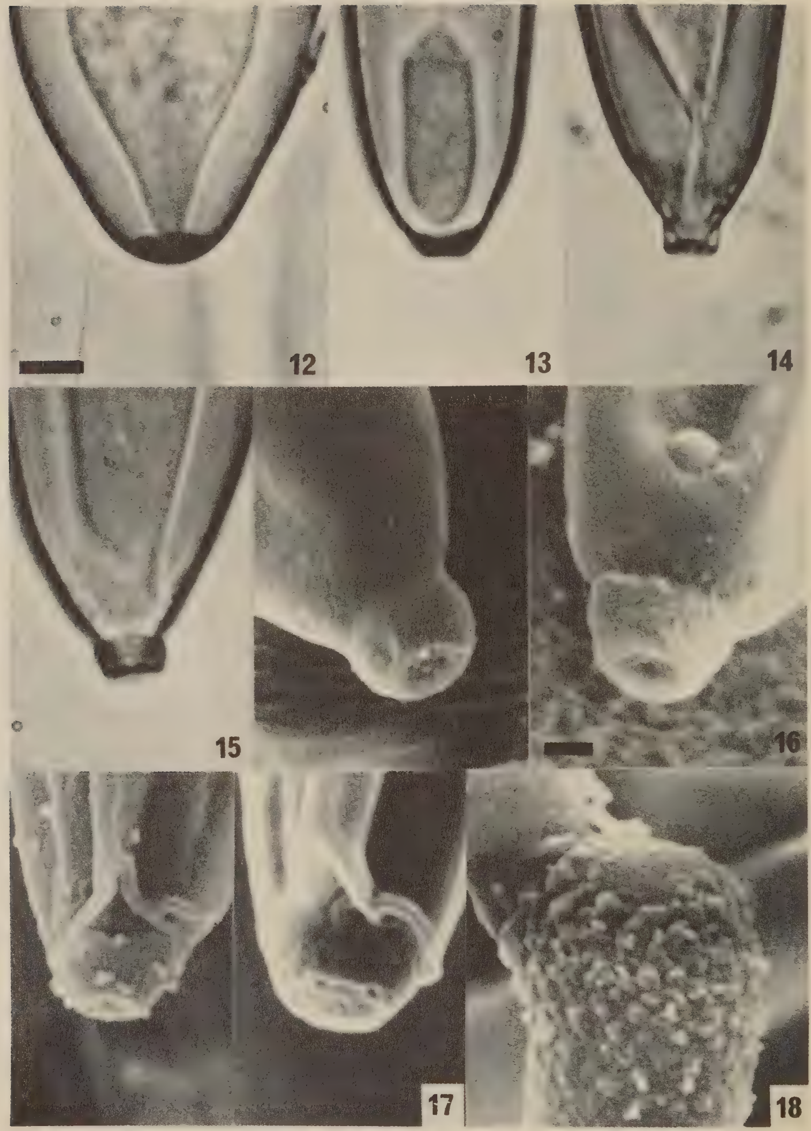
Other variations were seen. In some conidia the hilum took the form of two discrete rounded spots on either side of the pore, not tapering outwards. In others a flat dark disc was present, bridging the pore at right angles more or less midway between the outer and inner surfaces of the conidial wall.

Bipolaris maydis

The basal cell in the region of the hilum is commonly truncate, but in some conidia is rounded. The darkened elements of the hilum form two roughly lenticular spots on either side of a pore between the cell lumen and the exterior. The pigmented segments commonly are closely appressed to the outer contour of the wall, across the flattened base and tapering up the side for a short distance (Fig. 13). In some conidia a narrow band concolorous with the remainder of the wall is visible between the heavily pigmented region and the outer face of the wall.

The truncate base is also visible on conidia examined by scanning electron microscopy (Fig. 17). There is a flattened to slightly concave circular area with a central pore, which in some conidia is plugged. A ridge or flange of wall material projecting slightly at the outer edge of the flat area was visible in some conidia but not in others. Despite preparation by the critical point drying method, most conidia of *B. maydis* showed varying degrees of collapse. It is possible that the projecting marginal ridge illustrated is an artefact caused by this shrinkage.

My observations on the shape of the hilum in *B. maydis* agree with those of Aist et al. (1976), who published transmission electron micrographs of this structure.



Figs. 12-17 Hilum morphology in the generic types of *Drechslera*, *Bipolaris*, and *Exserohilum* (12) *D. tritici-repentis* (13) *B. maydis* (14) *E. turcicum*, median optical section (15) *E. turcicum*, upper focus (16) *E. turcicum*, scanning electron micrographs (17) *B. maydis*, scanning

Exserohilum turcicum

The basal cell bears in the hilum region a distinct protrusion up to about 2 µm long and 2.5-3 µm wide. This is the 'protruding hilum', and there is an abrupt change in contour of the wall where it projects. In optical section the protrusion is double-walled, and has the appearance of a truncate cone inserted into a short cylinder (Fig. 14). The inner wall appears to be a continuation of the conidial wall from above the protruding section. There are sometimes two darkened spots visible where the inner wall meets the flattened extremity of the protrusion. The outer wall of the exserted structure is thinner than the inner wall. It joins the outer edge of the truncate base of the hilum to the point on the basal cell where the change in curvature occurs. Pigmentation of the hilum is not well developed, and in the isolates studied was restricted to the flattened extremity of the hilar protrusion. In some conidia the region between the outer and inner walls of the protrusion is slightly darkened, and possibly could be interpreted as being continuous with the darkened end. The impression of darkening of the lateral walls is also given if the protrusion is examined on an upper focus by light microscopy (Fig. 15). The outer wall of the protrusion has the appearance of a collar around the inner cone, which is still visible but out of focus.

An enveloping structure around the hilar protrusion is also suggested by the scanning electron micrographs obtained (Fig. 16). There is often a clear discontinuity in the wall where the protrusion joins the basal cell. The end of the hilar protrusion is slightly concave, with a central pore which may be open or plugged.

Conclusions concerning hilum morphology in the generic types

Conidia of the type species for *Drechslera, Bipolaris* and *Exserohilum* differ in hilum morphology. The hilum in *D. tritici-repentis* is rounded smoothly, and the dark 'scar' visible at moderate magnification is contained with-

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electron micrographs (18) *B. maydis*, scanning electron micrograph of roughened conidiogenous node. Scale in fig. 12 represents 3 µm, figs. 12-15; in fig. 16 represents 1 µm, figs. 16-18.

in the contour of the base. The hila in *B. maydis* and *E. turcicum* differ from the hilum in *D. tritici-repentis* in being part of a protruding section at the base of the cell. The protrusion is slight in conidia of *B. maydis* and pronounced in conidia of *E. turcicum*, and these two species are readily separable by this characteristic.

My observations on hilum structure in conidia of *E. turcicum* provide new data on this aspect of generic characterization, and bring into question Luttrell's (1977) definition of the protruding hilum. His description and illustration of a darkening across the base and up the sides of the hilar protrusion are not supported by the observations and micrographs presented in this paper. Leonard and Suggs (1974) excluded *Helminthosporium micropus* from *Exserohilum* because they claimed the conidial wall rather than the hilum protruded. However it is clear that the conidial wall in *E. turcicum* participates in formation of the hilar protrusion. Despite these differences of definition and interpretation, the morphology of the conidial hilum in each of the type species is distinct and this characteristic could be used as a taxonomic criterion at generic rank.

CONIDIUM SHAPE AND COLOUR AND CONIDIOPHORE MORPHOLOGY IN THE GENERIC TYPES

Two of the conidial characteristics used in generic classification of this group of fungi, namely germination type and septum ontogeny, can be determined only with living material. In addition to the morphology of the hilum, conidial shape (Ito 1930; Shoemaker 1959, 1962) and colour (Luttrell 1964a; Shoemaker 1966) have been regarded as indicators of generic affinity. These characteristics in the generic types are examined in this section. Conidiophore morphology apparently has been ignored as a source of taxonomic information at generic rank, and this is considered also.

Conidia of *D. tritici-repentis* are essentially cylindrical. They do not taper, or do so only very slightly, from base to apex. Conidia are straight, or occasionally slightly curved, with a hemispherical apical cell and rounded conical basal cell. The colour of conidia is pale yellowish to yellow brown.

Conidia of *B. maydis* are fusoid, sometimes obclavate- or clavate-fusoid, curved, tapered towards both extremities. The apical cell is hemiellipsoidal and the basal cell hemiellipsoidal to truncate conic. Colour varies from pale olivaceous brown to mid reddish brown.

Conidia of *E. turcicum* are ellipsoid-fusiform, sometimes somewhat obclavate, straight or curved. The apical cell is hemiellipsoidal, and the basal cell hemiellipsoidal to more or less conic. Colour is yellowish brown to pale reddish brown.

Conidiophores of *D. tritici-repentis*, *B. maydis*, and *E. turcicum* are very similar. In all species they occur singly or are divergent in small fascicles. They are erect, straight or flexuous, usually becoming geniculate with the onset of sporulation, unbranched, multiseptate, cylindrical or slightly tapered. On natural substrates the basal cell of the conidiophore is often swollen, hemispherical or doliiform. Colour varies from pale brown to dark reddish brown, and is usually less intense in the apical region. The only difference noted between the type species was in roughening of the conidiogenous nodes. It was absent in *D. tritici-repentis* and *E. turcicum*, and present in *B. maydis*. In the last-named species most conidiogenous nodes examined were verruculose. Small projections occur in a band around the nodal section, but do not occur on the internodal segments or on the face of the scar left after secession of the conidium (Fig. 18).

Conclusions concerning conidium shape and colour and conidiophore morphology in the generic types

The shape of conidia in *D. tritici-repentis* is distinct from the shape of conidia in *B. maydis* and *E. turcicum*, and would allow *Drechslera* to be separated from *Bipolaris* and *Exserohilum*. Conidia of the type species for each of these two genera have a similar range of shapes, and this criterion could not be used to differentiate between them.

Colour of conidia is paler in the type species of *Drechslera* than in the type species of *Bipolaris* and *Exserohilum*. However colour is a variable character and is especially difficult to describe accurately for microscopic subjects. In a single conidium it is subject to change with variations in light quality and intensity. The mounting medium and age of conidia may also have an effect. Conidium colour has been described in general terms by students of *Drechslera* s.l. (Shoemaker 1959, 1962; Ellis 1971, 1976; Chidambaram et al. 1973). It is doubtful whether attempts to match colour with the standards sometimes used in mycology would add much to the generic taxonomy of the group.

The only aspect of conidiophore morphology for which differences were found between the generic types was roughening of conidiogenous nodes. It occurred regularly on conidiophores of *B. maydis*, but was not detected on conidiophores of *D. tritici-repentis* or *E. turcicum*, and possibly could be used as a generic criterion.

DISCUSSION AND CONCLUSIONS CONCERNING CHARACTERISTICS OF THE GENERIC TYPES

Germination of conidia has been considered by some authors to be an important characteristic for separation of groups in *Drechslera* s.l.. In particular, amphigenous germination has been contrasted with bipolar germination and used as one of the criteria to delimit subgenera (Niskado 1929a) or genera (Ito 1930; Shoemaker 1959). The results reported here show that the number of cells which germinate in each conidium is subject to wide variation depending on the source of conidia and the substrate on which they are incubated. Whether germination is amphigenous or bipolar is therefore rejected as a generic criterion. However one facet of germination does provide useful taxonomic information. It is the point of origin of the germ tube from the basal cell, and its direction of growth in relation to the long axis of the conidium. Using these characteristics, it is possible to distinguish *Drechslera* from *Bipolaris* and *Exserohilum*, as represented by their respective type species, but not to distinguish between *Bipolaris* and *Exserohilum*.

Primary septum ontogeny also has been used as a generic characteristic, but no information has been published on this aspect of conidial behaviour in most species in the group. The data reported here show that use of this criterion will allow *Drechslera* to be distinguished readily from *Bipolaris* and *Exserohilum*. In *Bipolaris* and *Exserohilum* the position occupied by the first conidial septum is similar and cannot be considered for separating the two taxa. The positions in which the second and third conidial septa form, however, differ in the type species for each of the three genera. This characteristic is proposed as a new generic criterion.

As noted for the characters of germination and primary septum ontogeny, consideration of conidium shape and colour allows *Drechslera* to be separated from *Bipolaris* and *Exserohilum*. Again, these two genera could not be distinguished if these were the only characteristics examined. Roughened conidiogenous nodes were found to occur only in the type species of *Bipolaris*, and this character might be an added generic criterion.

Hilum morphology is distinctive in each of the type species, and three taxa can be distinguished by an examination of this character alone. Observations on the structure of the protruding hilum revealed that its morphology has been misinterpreted by other authors, but this does not detract from its usefulness as a generic characteristic.

It is concluded from this study of the type species that *Drechslera, Bipolaris,* and *Exserohilum* differ sufficiently in several morphological and biological characteristics to be retained as separate genera. These characteristics are conidium shape, hilum morphology, point of emergence and direction of growth of the germ tube from the basal cell, positions occupied by the first, second, and third conidial septa, and presence or absence of ornamented conidiogenous nodes on conidiophores. A summary of the differences between the genera with respect to these parameters is presented in Table 5.

Table 5. Differentiating characters for *Drechslera, Bipolaris* and *Exserohilum* as determined by a study of the type species

Character	*Drechslera*	*Bipolaris*	*Exserohilum*
Conidia			
Shape	cylindrical	fusoid	ellipsoid-fusiform
Hilum	non-protruding, rounded	protruding slightly, truncate	protruding strongly, truncate
Basal germ tube	lateral	semiaxial	semiaxial
First septum	delimits basal cell	median to submedian	submedian
Second septum	median in distal cell	delimits basal cell	supramedian
Third septum	distal	distal	median
Conidiophores			
Conidiogenous nodes	smooth	verruculose	smooth

MORPHOLOGICAL AND BIOLOGICAL ATTRIBUTES IN OTHER SPECIES OF *DRECHSLERA*, *BIPOLARIS*, AND *EXSEROHILUM*

Discontinuities in certain morphological and biological characteristics of the type species of *Drechslera*, *Bipolaris* and *Exserohilum* have been reported above. Considered in total, they offer grounds for regarding the three genera as distinct. If the attributes chosen are good generic criteria they should be strongly correlated, and widely applicable to the species assigned to the different genera. Results of observations on a range of species variously disposed among the three genera are presented below.

CONIDIUM GERMINATION IN SPECIES OF *DRECHSLERA* S.L.*

It was shown above that germination behaviour in *D. tritici-repentis* is quite distinct from that in the other two generic types, *B. maydis* and *E. turcicum*. Germination in these two species is very similar, the only difference noted being the tendency for some germ tubes to be lateral from the basal conidial cell in *E. turcicum*.

Polarity or otherwise of germ tube emergence is too variable a characteristic to be useful in separating genera. The point at which the germ tube emerges from the basal cell, and the direction in which it grows, are much more constant. In the type species, the basal germ tube is lateral in *D. tritici-repentis* and semiaxial in *B. maydis* and *E. turcicum*. In this section, this criterion was used in assigning species to groups based on germination behaviour.

Results

Two major groups of species were identified. In these, germination was similar to that of *D. tritici-repentis* (Table 6) and *B. maydis* (Table 7) respectively. For some other species confident assignment to one of these germination groups was difficult, and this small assemblage is listed in Table 8.

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* Where a binomial in *Drechslera* has been proposed for the species studied, this name is generally used in the text. Recommendations concerning generic disposition of the species examined are presented in Table 20.

In many species, each conidial cell which germinated commonly did so by forming one germ tube. Sometimes two germ tubes arose from a single cell, for example in *D. australiensis* M.B. Ellis, *D. bicolor* (Mitra) Subram. & Jain, *D. biseptata* (Sacc. & Roum.) Richardson & Fraser, *D. erythrospila* (Drechsler) Shoem., *Exserohilum prolatum* Leonard & Suggs, and *D. zeicola* (Stout) Subram. & Jain. Germinating conidia of *D. siccans* (Drechsler) Shoem., *D. fugax* (Wallr.) Shoem., and *D. erythrospila* often had two lateral germ tubes positioned on opposite sides of the basal cell (Fig. 20). Conidia incubated on glass commonly formed appressoria on a proportion of the germ tubes. Appressoria were not seen on germ tubes from conidia incubated on water agar.

Notes on the germination groups and representative species are presented below.

Species with germination similar to that of *Drechslera tritici-repentis*

Species were assigned to this group if conidia germinated by producing a lateral germ tube from the basal cell. Eighteen species were included (Table 6). A feature of the group was the high number of species in which amphigenous germination was absent or at a low level. The only species in which it predominated were *D. poae* (Baudys) Shoem. (Fig. 19), *D. nobleae* McKenzie & Matthews, and *D. bromi* (Died.) Shoem. Within a species, amphigenous germination sometimes showed wide variation. For example it varied from 4% to 56% for *D. catenaria* (Drechsler) Ito, and from 8% to 56% for *D. phlei* (Graham) Shoem.

Conidia of *D. brizae* (Nisik.) Subram. & Jain, *D. biseptata*, and *D. dematioidea* (Bubák & Wrob.) Subram. & Jain are short compared with others in this group. Germination from only the basal cell was common in *D. biseptata* and *D. dematioidea*. In *D. brizae* bipolar emergence predominated. The basal germ tube in this species often emerged from the lower half of the cell, always clear of the hilum, and commonly grew at a wide angle to the long axis of the conidium (Fig. 21). No amphigenous germination was detected in *D. brizae*, although large numbers of germinated conidia were observed. In one test a germinated conidium lacking cytoplasm in the basal cell was seen. The single germ tube originated from the second cell from the base, but first grew into the lumen of the empty basal cell then penetrated the lateral wall to emerge just below the septum. In a corresponding example with *E. turcicum* the germ tube emerged near the hilum, displacing it considerably, and grew in a semiaxial direction.

Most conidia of *D. nobleae* germinated from only one or two cells, each by a single germ tube. Conidia with two germ tubes had commonly produced one from the apical cell, and the other from a point approximately one quarter of the total spore length from the base. Where septa were still visible, this germ tube was seen to originate from the second cell from the base (Fig. 26). Of 25 germinated conidia of *D. nobleae* selected at random, 14 had only one germ tube (from the second cell), nine had two germ tubes (one from the apex and one from the second cell), and two had germ tubes arising from other than the apical and second cells. McKenzie and Matthews (1977) reported that conidia in this species usually germinated from the second cell, and occasionally also from the apical cell.

Table 6. Species* in which conidium germination is similar to that of *Drechslera tritici-repentis*

andersenii	dactylidis	nobleae
avenae	dematioidea	phlei
biseptata	dictyoides	poae
brizae	erythrospila	siccans
bromi	fugax	teres
catenaria	graminea	tuberosa

* Used in this and subsequent tables in the sense of *Drechslera* s.l., although the epithets for some species have not been formally combined in *Drechslera*.

Observations on primary septum development in this species (see below) revealed a possible morphological explanation for this phenomenon. In 1-septate conidium initials, the periclinal wall is markedly thinner in the region just below the septum (Fig. 34). The proximal segment delimited by the primary septum is subsequently further divided into two cells, the upper of which coincides with the thin-walled region. This latter cell remains thin-walled in most mature conidia (Fig. 34), and is the cell most commonly involved in germination. These observations are in agreement with those recently published by Morrison (1982).

Species with germination similar to that of *Bipolaris maydis*

Species were assigned here if the basal cell produced a semiaxial germ tube on germination. Forty-nine species were included (Table 7), as were all isolates listed in part 2 of the appendix.

Table 7. Species in which conidium germination is similar to that of *Bipolaris maydis*

---

australiensis
australis
bicolor
cactivora
chloridis
clavata
coicis
colocasiae
crustacea
cylindrica
cynodontis
dactyloctenii
ellisii
gedarefensis
hawaiiensis
holmii
homomorphus
incurvata
indica
iridis
kusanoi
leersiae
melinidis
micropus
monoceras
multiformis
neergaardii
nicotiae
nodulosa
oryzae
ovariicola
papendorfii
pedicellata
peregianensis
perotidis
prolatum
ravenelii
rostrata
sacchari
setariae
sorghicola
sorokiniana
spicifera
stenospila
subpapendorfii
urochloae
victoriae
yamadae
zeicola

Polar germination predominated in this group, with one or both polar cells producing a germ tube (Figs. 23, 24). An exception to this pattern was provided by *D. hawaiiensis* M.B. Ellis, where conidia often germinated by a germ tube from one pole and a conidiophore from the other (iterative germination). Many conidiophores also were formed terminally or laterally on the germ tubes in this species, and in some instances secondary conidia were present. *D. spicifera* (Bain.) Arx and *D. australiensis* are species in which conidial morphology is similar to that of *D. hawaiiensis*. Direct formation of a conidiophore on one polar cell was seen in germinated conidia of *D. spicifera,* but not *D. australiensis.*

Conidia which germinated from median as well as polar cells commonly did so from only one median cell. Apical germ tubes in all speices were axial to semiaxial. There are some species where a proportion of end cells swelled to form a thin-walled, more or less globose vesicle from which the germ tubes grew, for example in *D. cynodontis* (Marig.) Subram. & Jain, *D. leersiae* (Atk.) Subram. & Jain, and *D. stenospila* (Drechsler) Subram. & Jain. The phenomenon was more common on glass than on water agar. Similar polar vesicles have been illustrated by Nisikado (1928a) for *D. oryzae* (B. de Haan) Subram. & Jain.

The hilum was displaced to varying degrees by germ tube growth. No effect was noted in *D. coicis* (Nisik.) Subram. & Jain but in *D. incurvata* (Ch. Bernard) M.B. Ellis, *D. multiformis* Jooste, and *D. rostrata* (Drechsler) Richardson & Fraser the hilum was often pushed to one side. The magnitude of the displacement was sometimes as great as in *E. turcicum,* for example with *D. urochloae* (Putterill) Subram. & Jain.

Mature conidia of *D. sorghicola* (Lefebvre & Sherwin) Richardson & Fraser often have secondary conidiophores arising from the apical cell while the conidium is still attached to the primary conidiophore. Such conidia usually germinated in a 'bipolar' manner, with the second germ tube arising at the apex of the conidiophore.

Germination in species with a protruding conidial hilum was very similar to that in other species assigned to the group. *E. turcicum* sometimes showed lateral emergence of the basal germ tube, but this was not detected in any of the other species with a protruding hilum. Amphigenous germination was observed in conidia of only two species, *D. monoceras* (Drechsler) Subram. & Jain and *E. prolatum*, in addition to *E. turcicum*.

Conidia of *D. pedicellata* (Henry) Subram. & Jain germinated very poorly or not at all on water agar. In one test, 12% germination occurred on water agar and 88% on PDA. On the former medium many germ tubes were short, branched, and thickened, with swollen terminal segments resembling young chlamydospores or appressoria. The germ tubes formed on PDA were normal. Conidia of this species incubated on glass did not germinate.

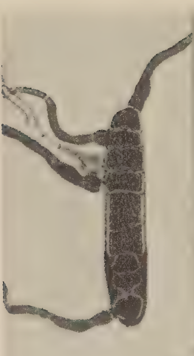
Atypical germination group

Species were placed in this group (Table 8) if there was variation in the point of germ tube emergence from the basal cell. Most isolates showed variation from distinctly semiaxial to distinctly lateral. Polar germination was predominant. Notes on the four species comprising this group are given below.

D. campanulata (Lév.) Sutton. Apical germ tubes were semiaxial to axial. Basal germ tubes almost always emerged close to the hilum, and grew at various angles. Some were at right angles to the long axis, and others distinctly semiaxial, in some instances displacing the hilum (Fig. 28). Rarely the basal germ tube emerged well clear of the hilum, and grew laterally (Fig. 27).

D. tetrarrhenae Paul. Only polar germination occurred. Basal germ tubes were semiaxial to predominantly lateral (Fig. 22). In the latter category many emerged close to the hilum. These germ tubes occasionally were so close to the hilum as to displace it slightly. Apical germ tubes often grew at a similar angle, arising at the point on the wall where the sides begin the apical curve.

D. tripogonis A.S. Patil & V.G. Rao. Up to 50% of conidia had the germ tube emerging more or less at the median point on the basal cell, and growing out at a wide angle (Fig. 29). Less than half the basal germ tubes were semiaxial (Fig. 30). Some apical germ tubes were lateral.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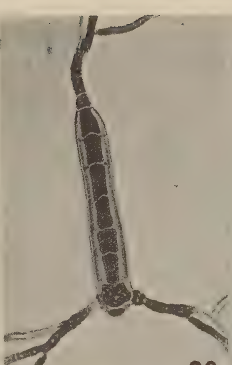
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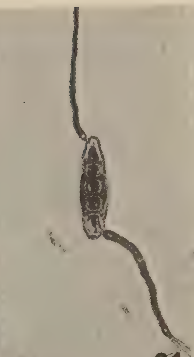
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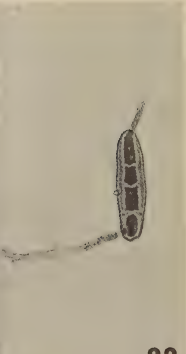
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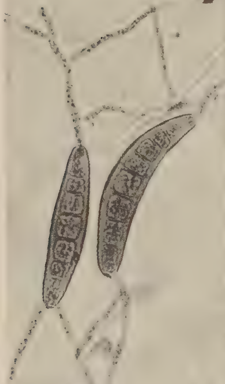
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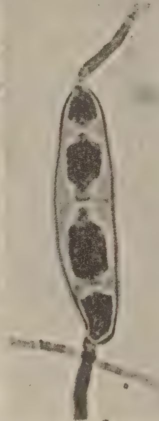
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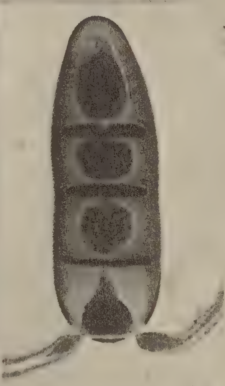
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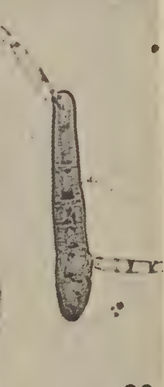
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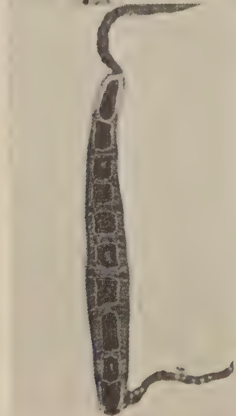
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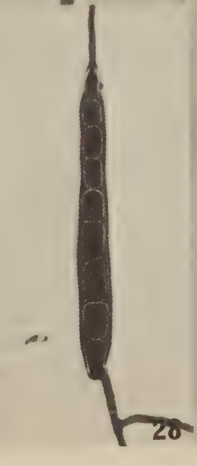
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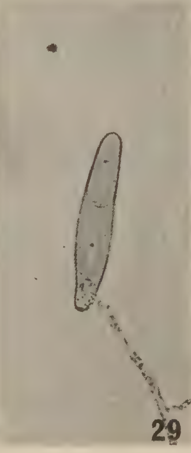
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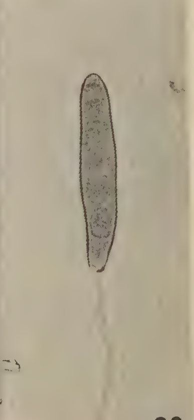
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D. triseptata (Drechsler) Subram. & Jain. Most conidia germinated only from the basal cell. Bipolar germination, or apical emergence only, was rare in all isolates. Commonly, two germ tubes arose on either side of the hilum, very close to it, and each grew at an angle of approximately 45°. Some were at wider angles, occasionally perpendicular to the long axis (Fig. 25). When only one germ tube was present, it also arose close to the hilum and grew at a wide angle.

Table 8. Emergence of germ tubes from basal cells in conidia of four *Drechslera* species

Species	Isolates	Emergence*			
		S	45	Lh	Lm
campanulata	6170	33	41	26	-
	7914	6	22	22	-
	60/78	7	19	24	-
tetrarrhenae	7725a	7	-	28	15
	7765b	7	-	72	21
tripogonis	77158-4	35	15	-	50
	77166-3	32	30	-	38
	77166-6	38	23	-	39
triseptata	7754	-	100	-	-
	6120	-	100	-	-
	14769	-	100	-	-

* Figures = numbers in each germination category. S = semiaxial; 45 = from near hilum but inclined at 45° to long axis; Lh = lateral from adjacent to hilum; Lm = lateral from median region of basal cell.

Figs. 19-30. Germination in *Drechslera* s.l. (19) *D. poae* (20) *D. siccans* (21) *D. brizae* (22) *D. tetrarrhenae* (23) *B. peregianensis* (24) *B. australis* (25) *D. triseptata* (26) *D. nobleae* (27,28) *D. campanulata* (29,30) *D. tripogonis*. Scale represents 10 µm, figs. 24,25; 25 µm, all other figures.

Discussion

The results obtained with conidial germination in other species support the conclusion reached after examining the generic types, that polarity *per se* has little value as a taxonomic criterion at generic level. Thus *D. tetrarrhenae*, which has a *Pyrenophora* state, germinated only from end cells. Paul (1971) reported occasional germination from median cells in this species. Other species with *Pyrenophora* teleomorphs germinated amphigenously, but often with most conidia producing germ tubes from the polar cells only. These species are *D. avenae* (Eidam) Scharif, *D. dictyoides* (Drechsler) Shoem., *D. erythrospila*, and *D. teres* (Sacc.) Shoem.. Conversely some species with *Cochliobolus* teleomorphs exhibited amphigenous germination, namely *D. cynodontis*, *D. oryzae*, *D. setariae* (Saw.) Subram. & Jain, and *D. victoriae* (Meehan & Murphy) Subram. & Jain.

The other aspect of germination proposed as a generic criterion, the origin and direction of germ tube growth from the basal cell, appears to be a more reliable taxonomic characteristic. In most species for which a *Pyrenophora* teleomorph is known, the germ tube from the basal cell was lateral. Exceptions were *D. campanulata*, in which over 30% of basal germ tubes were semiaxial in germinated conidia from one isolate, and *D. tetrarrhenae*, where up to 14% of basal germ tubes were in this category (Table 8). Drechsler (1923) illustrated bipolar germination by two conidia of *Helminthosporium cyclops* Drechsler (= *D. campanulata*). The basal germ tube is shown as lateral in one, semiaxial in the other, but from near the hilum in both examples. He described the basal germ tube as arising from the thin-walled region surrounding the hilum, and indicated similarity to *H. sativum* Pamm., King & Bakke. Wallace (1959) found mostly bipolar germination in conidia of *Podosporiella verticillata* O'Gara (= *D. campanulata*) incubated on wheat meal agar, and mostly apical emergence on water agar. Sprague (1962) transferred *H. cyclops* to *Bipolaris*, but it is not clear from his account whether the fungus was cultured and conidia germinated. Drechsler (1923) was aware of the differences in conidial morphology and germination behaviour which were used by Nisikado (1929a) in distinguishing two subgenera in *Helminthosporium*. Despite this he also thought that *H. cyclops* conformed in conidial morphology with species known to have *Cochliobolus* teleomorphs (Drechsler 1934). Subsequently Shoemaker (1966) transferred the name of the anamorph to the genus *Drechslera*, as *D. verticillata* (O'Gara) Shoem., and indicated that the germ tube from the basal cell is lateral. Sutton (1976) has shown that an earlier epithet is available in the name *Angiopoma campanulatum* Lév..

A large proportion of the species with *Cochliobolus* teleomorphs germinated by producing a semiaxial germ tube from the basal conidial cell. In *D. tripogonis*, which has a *Cochliobolus* state, up to 50% of germ tubes from the basal cell emerged well clear of the hilum and grew laterally (Table 8). This behaviour is characteristic of species with *Pyrenophora* teleomorphs. Lateral germ tubes from the basal cell were seen also in *D. ravenelii* (Curt.) Subram. & Jain, but they were not as common as reported by Luttrell (1976).

In most species, distinction between the lateral and semiaxial types of germ tube emergence presented no problem. For others such as *D. campanulata*, it was sometimes difficult to assign a germ tube to one or the other category. Luttrell's definitions do seem to allow some overlap. Lateral germ tubes 'emerge from any point on the basal cell and grow outward at various angles, often at right angles, to the longitudinal axis of the conidium'. Semiaxial germ tubes 'emerge from a point adjacent to the hilum, often so close that the hilum is pushed to one side, and grow out approximately along the longitudinal axis of the conidium' (Luttrell 1963a). These definitions of lateral and semiaxial suggest that a germ tube could be classified in the former category even though it emerged immediately adjacent to the hilum, provided growth was not 'approximately along the longitudinal axis'. A continuum of types can be envisaged, with the point of germ tube emergence gradually approaching the hilum, and the angle to the long axis becoming more acute. Some attempt to resolve this difficulty in definition was made with the data presented in Table 8, where four categories of emergence and direction of growth were recognized.

It is concluded that useful data can be obtained by germination of conidia. There is good correlation between teleomorphs and basal germ tube behaviour for most species where perfect states are known. Germination alone would not always provide a good indication of possible teleomorph connections, however, because of variability in this aspect of conidium biology. In these instances, other characteristics such as those examined in the following sections would have to be ascertained.

SEPTUM ONTOGENY IN SPECIES OF *DRECHSLERA* S.L.

It was shown previously that septum ontogeny in developing conidia of *D. tritici-repentis* is different from that in conidia of *B. maydis* and *E. turcicum*. In the first species the primary septum forms close to the base of the conidium, delimiting proximally a cell destined to be the basal cell of the mature conidium. In *B. maydis* and *E. turcicum* the first septum is commonly submedian, but tending to be further from the midpoint of the conidium in *E. turcicum*. The conclusion was reached that these two species could not be distinguished by this criterion alone. A consideration of second and third septum development, however, allows separation of these taxa. In this section, data are presented on septum ontogeny in conidia from other species and unnamed isolates.

Two major groups of species could be recognized solely on the basis of primary septum development, corresponding with the patterns found in *D. tritici-repentis* and *B. maydis* respectively. In a third group, septum ontogeny was similar to that of *E. turcicum*. Species which could not be assigned to one of these groups are discussed in the final section of the results.

The time taken for sporulation to be initiated varied widely between species. One-septate conidia were produced very rapidly by some species, namely *D. multiformis* (2 h), *D. sorghicola* (4 h), and *D. kusanoi* (Nisik.) Subram. & Jain (3 h). Other took much longer to reach the same stage of development, viz. *D. biseptata* (22 h), *D. bromi* (Died.) Shoem. (22-23 h), *D. dictyoides* (22 h), *D. poae* (19-24 h), and *D. siccans* (23-24 h). Where species were tested more than once, sometimes this characteristic was constant, for example in *D. leersiae* (22, 23 h), *D. pedicellata* (16, 19 h), *D. urochloae* (14, 16 h). For other species it varied between experiments, for example in *D. australiensis* (7, 22 h), *D. brizae* (9, 24 h), *D. hawaiiensis* (5, 22 h), *Exserohilum prolatum* (4, 20 h), and *D. zeicola* (7, 16 h). This variability within and between species caused some difficulties in attempts to maintain continual observation. In several instances, development was arrested by chilling plates at 5°C for approximately 10 hours. Subsequent development when the plates were returned to ambient temperatures appeared normal, and mature conidial morphology was as expected for the species. The times for development to the 1-septate stage mentioned above do not include any period spent at the lower temperature.

Species in which septum ontogeny corresponds with that in *Drechslera tritici-repentis*

Twenty species were included in this group (Table 9). One-septate conidia of four of the species are illustrated in Figures 31-33, 35.

There was usually constancy of results for the various parameters measured when more than one isolate of a species was tested, and also when a given isolate was examined on separate occasions. The quotient b/a was commonly 3.0 or greater. It was greatest in *D. bromi* (5.3), which has very long conidia (Fig. 35), and least in isolates of *D. phlei* and *D. poae* (2.5 in each). Increase in conidium length with maturation varied widely between species. It ranged from ca. 10% for *D. avenae* to ca. 80% for *D. dictyoides*.

Table 9. Species in which conidial primary septum ontogeny corresponds with that in *Drechslera tritici-repentis*

andersenii
avenae
biseptata
brizae
bromi
campanulata
catenaria
dactylidis
dematioidea
dictyoides
erythrospila
fugax
graminea
phlei
poae
siccans
teres
tetrarrhenae
triseptata
tuberosa

The second septum to form in conidia of *D. tritici-repentis* occurred in a median position in the upper cell. The third septum formed in the distal cell of the 2-septate conidium. A similar progression of septation was noted for some of the species included in the *D. tritici-repentis* group (Fig. 33), and these are listed in Table 10.

Table 10. Species in which progression of conidial septation corresponds with that in *Drechslera tritici-repentis*

andersenii	2*	catenaria	2	poae	3
avenae	2	dematioidea	3	siccans	2
biseptata	3	dictyoides	2	teres	2
brizae	3	erythrospila	2	triseptata	3
bromi	2	fugax	2	tuberosa	3

* 2, conidia with one and two septa observed; 3, conidia with one, two and three septa observed.

Species in which septum ontogeny corresponds with that in *Bipolaris maydis*

Thirty-eight species showed primary septum development similar to that of *B. maydis* (Table 11). In addition all isolates listed in part 2 of the appendix were included with this group.

Luttrell (1963a) used developing conidia of *D. sorokiniana* (Sacc.) Subram. & Jain as an example in which the first septum is median, and this was confirmed. In 19 other species values for *b/a* were 1.9-2.2, indicating that in these taxa the primary septum was approximately median in young conidia. When *b/a* is about 2.3, the septum is perceived as being submedian without measurement, and becomes distinctly so with increasing values for this quotient. In 8 species the figures for *b/a* were 2.5 or greater, and in these the primary septum in most conidia was clearly below the mid-point (Fig. 36). These latter values are similar to those obtained for some of the species listed in Table 10. However, the parameter *x* distinguishes the members of these two groups clearly.

The taxa in Table 11 could be separated into two groups by arbitrary selection of a value for *b/a* to give 'median' and 'submedian' categories, but this was not considered warranted. The characteristic is variable in *B. maydis*, and in contrast with that in the *D. tritici-repentis* group. Species in which the *b/a* quotient approached 2.0 generally were those with short conidia, and in which the increase in length with maturation was not great (Fig. 42). An exception was *D. urochloae*, a species with very long conidia in which there was a large increase in length after the first septum formed.

Once septa began to form, the mature state was reached quickly in conidia of some species. For example in *D. oryzae*, conidia passed from the stage of aseptate to predominantly 4-9-septate in a period of 75 minutes. In contrast cultures of *D. pedicellata* produced large numbers of aseptate conidia within 14 hours, but 1-septate conidia were not detected for a further five hours.

Table 11. Species in which conidial primary septum ontogeny corresponds with that in *Bipolaris maydis*

australiensis
australis
bicolor
cactivora
chloridis
coicis
colocasiae
cynodontis
dactyloctenii
ellisii
hawaiiensis
homomorphus
incurvata
iridis
kusanoi
leersiae
melinidis
multiformis
neergaardii
nicotiae
nodulosa
oryzae
ovariicola
papendorfii
pedicellata
peregianensis
perotidis
sacchari
setariae
sorghicola
sorokiniana
spicifera
stenospila
subpapendorfii
urochloae
victoriae
yamadae
zeicola

The second septum in developing conidia of *B. maydis* forms near the base, cutting off a cell below it which is not further divided and becomes the basal cell of the mature conidium. The third septum occurs in the cell above the primary septum. In the *B. maydis* group, some other species and isolates showed the same developmental pattern (Fig. 37). They are listed in Table 12.

Table 12. Species and isolates in which progression of conidial septation corresponds with that in *Bipolaris maydis*

colocasiae	3[†]	Eragrostis sp.	2
cynodontis	2	Microlaena stipoides	2
ellisii	2	Panicum maximum var. trichoglume	2
incurvata	3	P. pygmaeum	3
leersiae	3	Pennisetum clandestinum	3
urochloae	3	Triticum aestivum	2
victoriae	2	Zea mays	3
....		Zoysia macrantha	2
Axonopus affinis*	3		
Brachiaria decumbens	3		

† See footnote, Table 10.

* Hosts for unidentified isolates.

Species in which septum ontogeny corresponds with that in *Exserohilum turcicum*

In the species comprising this group (Table 13) the primary septum tends to be nearer the base of the conidium than it is in species listed in Table 11. Values for *b/a* are correspondingly greater, 2.6-4.1 compared with 1.9-2.8.

The second septum to form in developing conidia of *E. turcicum* cuts off an apical cell approximately equal in length to the cell delmited at the base by the primary septum. This type of progression was seen in six other species, namely *D. gedarefensis* El Shafie, *D. indica* (Rai, Wadhwani & Tewari) Mouchacca, *D. micropus* (Drechsler) Subram. & Jain, *D. monoceras* (Fig. 38), *E. prolatum*, and *D. rostrata*.

The third septum in conidia of *E. turcicum* commonly forms between the first and second septa, that is, median in the young conidium. Other species grouped here because they showed the same sequence of septation were *D. gedarefensis*, *D. micropus*, and *E. prolatum*. Some variability was noted in the position occupied by the second septum in conidia of *E. turcicum*. Similarly in *D. monoceras* this septum sometimes was median, or even below the primary septum, instead of forming distally.

Table 13. Species in which conidial septum ontogeny corresponds with that in *Exserohilum turcicum*

gedarefensis	monoceras
holmii	prolatum
indica	rostrata
micropus	

Species with variable or atypical primary septum ontogeny

The position occupied by the first conidial septum has been determined for many species and unidentified isolates of *Drechslera* s.l.. In most of these fungi, primary septum ontogeny has corresponded with that exhibited by *D. tritici-repentis, B. maydis,* or *E. turcicum.* In seven species (Table 14), septum development took place in some other way or was variable. Four of these species were consistent in their aberrant behaviour. Data obtained in some tests with three species, namely *D. iridis, D. pedicellata,* and *D. urochloae* were consistent with those recorded for other species listed in Table 11. Consequently they have been included in that table, in addition to being discussed here.

B. clavata Alcorn. The primary septum in young conidia of this species was usually distinctly supramedian (Fig. 41). It eventually became the penultimate septum. The second septum formed towards the base, delimiting the basal cell. In 3-septate conidia the second cell from the base was usually longer than any of the other cells. Only two conidia with a median primary septum were seen.

D. iridis (Oud.) M.B. Ellis. In a test where the medium was PDA (Table 14), 18 one-septate conidia were detected in the slides prepared. Of these conidia, 12 had the septum in the distal third, and the data in the table are from these conidia. Four had the primary septum median (b/a = 2.0), and in two it was in the basal third (b/a = 3.3). The data in the second line of results are from a culture on V-8A. No conidia had formed after 14 hours on the first day of observation. The plate was then chilled at 5^{o}C overnight. Most 1-septate conidia seen on the second day had the septum delimiting the basal cell. Three conidia were seen with the primary septum in the upper half (b/a = 1.4), as occurred with conidia from PDA. Conidia from V-8A were much larger when septation began than were those from PDA.

Isolate DAR 29777 of *D. iridis*, obtained subsequent to the screening reported above, was tested too. The primary septum formed towards the base, or in a median position. The relative frequency of the two categories was approximately 3:2. The numerical data for conidia in each category were as follows:

Primary septum	a	a_1	b	b_1	s	x	b/a
median	20.6	6.8	43.3	50.2	6.4	3.1	2.1
basal	15.4	6.8	48.0	50.2	6.4	2.2	3.1

Clearly the septum classed as 'basal' does not delimit the basal cell, as was the case with isolate 6129 cultured on V-8A. There is very little increase in conidial length with maturation, and x probably indicates the ultimate position of the first-formed septum.

D. nobleae. The primary septum in conidia of this species forms towards the base. It delimits a basal segment which invariably is divided further. The second septum forms in the basal segment below the first septum, delimiting a portion which becomes the basal cell of the mature conidium. The basal segment has a markedly thinner periclinal wall in the upper section just below the primary septum (Fig. 34). This thinner-walled section is destined to be the cell from which a germ tube commonly arises in this species (Fig. 26). Measurements of the lateral wall in 15 mature conidia of isolate 15063 were: basal cell, 3-4 µm; second cell, 1-2 µm; third cell, 3-4 µm. Occasionally two septa form in the segment below the primary septum. The sequence in which they are laid down could not be determined.

D. pedicellata. In one test using PCA as the substrate, the primary septum in conidia of isolate 4951 formed in a median position. In another test using the same medium and isolate, the first septum was supramedian (Table 14).

Isolates 4951 and 113 were compared on another medium, V-8A. In isolate 113 only one mode of development was seen, with the septum above the median position. Conidia from the culture of 4951 had the primary septum supramedian (4951(1) in Table 14), or distinctly towards the base (4951(2)). The latter pattern was approximately four times as numerous as the former, and similar to that shown by *E. turcicum*.

One other isolate (8046) was examined subsequent to the tests reported above. Only four 1-septate conidia were found and the septum was below the median point ($b/a = 2.5$). There were many 2-septate conidia in the same slides with septa approximately equidistant from base and apex respectively. In some conidia both septa were very faint as though just forming. It is possible that two septa sometimes form synchronously in this species.

D. tripogonis. Septum ontogeny in this species was similar to that in *D. nobleae*. The basal segment cut off by the first septum was divided into two cells by the second septum that formed. No additional septa were laid down in this segment.

D. urochloae. The first conidial septum was median on three occasions (Table 11), and in two other tests it formed towards the base of the conidium (Table 14). There was wide variation in the size reached before the first septum formed in the latter instances.

Unidentified species from *Crinum zeylanicum* L. In this species the primary septum formed towards the conidium base (Fig. 40). The basal segment subsequently was divided into two cells, as happened with *D. nobleae* and *D. tripogonis*. However this took place after the second septum had formed above the first, in an approximately median position. The value for x is probably a good indication of the position which the primary septum eventually occupies, because the conidia are almost of mature length when it forms.

Septum ontogeny in conidia of *Drechslera ravenelii* and similar species

Isolates of *D. ravenelii* were included in several experiments but no 1-septate conidia were observed. In this species, conidiophores and conidia were produced rapidly under the experimental conditions used. During one test, aseptate conidium initials were present after 3-3.5

Table 14. Species in which conidial primary septum ontogeny does not correspond with that in *D. tritici-repentis*, *B. maydis*, or *E. turcicum*

Species	Isolate	a	a_1	b	b_1	s	x	b/a
clavata	77144c	44.5	23.0	73.0	82.3	3.4	2.4	1.6
	77144c†	40.0	13.5	61.8	68.0	4.1	2.9	1.5
iridis	6129	20.4	6.9	28.2	44.4	5.0	2.8	1.4
	6129	10.0	9.0	47.8	54.5	5.4	1.0	4.8
nobleae	5063*	24.2	15.3	67.5	88.5	5.5	2.0	2.8
	5063*	31.5	14.7	74.0	82.5	5.2	3.0	2.3
	15063	21.2	14.3	64.5	85.5	5.5	2.0	3.0
	112	25.1	16.8	70.0	92.3	5.2	2.0	2.8
	5832	24.8	12.6	63.8	91.7	5.9	2.5	2.6
pedicellata	4951*	17.2	15.1	30.5	82.8	5.9	1.3	1.8
	4951(1)	43.3	14.6	75.7	75.7	5.7	3.9	1.7
	4951(2)	22.3	14.6	64.2	75.7	5.7	2.0	2.9
	113	46.1	14.8	84.5	86.5	7.0	3.8	1.8
tripogonis	77158-5	22.0	12.2	64.5	72.7	4.0	1.9	2.9
	77166-3	21.9	12.0	67.0	76.7	4.5	2.0	3.1
	77166-6	22.0	13.1	71.2	84.0	4.5	1.8	3.2
urochloae	77127*	40.0	15.1	149.0	173.2	12.5	3.1	3.7
	77127†	17.7	10.1	84.3	97.7	8.0	2.0	4.8
undet. ex. Crinum	21067	19.5	9.2	77.3	78.5	7.7	2.0	4.0
	21067*	17.9	9.1	66.7	75.4	7.3	2.0	3.7
	21067	19.2	9.1	80.5	86.2	8.0	2.0	4.2

† Data from culture on PDA; * data from culture on PCA.

hours, and some conidia had matured after a further 1.5 hours. Mixed with the mature conidia were many with only two septa, although of mature size. The septa in these 2-septate conidia occurred approximately 15 µm from each end. In some the septa were very thin and only just discernable, indicating recent formation. It seemed possible that these septa developed synchronously, or in very rapid succession. In either case, the primary septum in this species cannot be median.

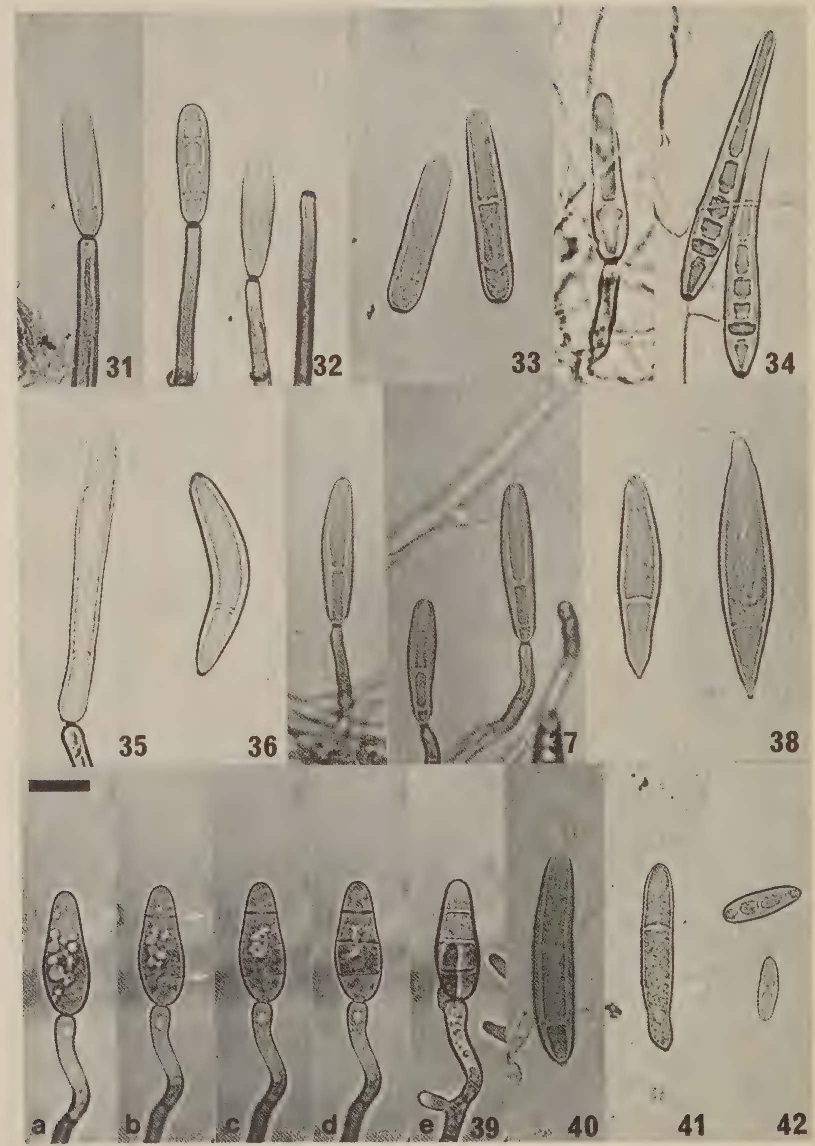
Similar results were obtained with isolates of *Bipolaris cylindrica* Alcorn, another inflorescence-infecting species from *Sporobolus*. Again, development was rapid, with 2-septate conidia being present after approximately five hours. In one test, measurements were taken from such conidia to indicate the relative positions of the two septa. The data are presented below.

Isolate	a	a_2	b	b/a	b/a_2
77152	13.5	38.4	49.7	3.7	1.3
77154	15.3	42.6	59.0	3.9	1.4
7824	13.4	37.4	53.5	4.0	1.4
7835	15.8	40.0	55.5	3.5	1.4

Data for 3-septate conidia show that the third septum forms in a median position:

Isolate	a_3	b	b/a_3
77152	26.3	54.3	2.1
77154	29.6	59.3	2.0
7824	25.5	58.0	2.3

The possibility that two septa form synchronously in young conidia of these ovariicolous species was investigated using slide cultures. Conidiophores and conidia are commonly produced within the agar block, in addition to on its outer faces. Usually, embedded conidia suitable for continual observation and photomicrography could be found at several points. With *D. ravenelii* (Fig. 39) and *B. cylindrica* there is no doubt that in many conidia, two septa differentiate simultaneously. The septa are observed initially as two very fine lines across the young conidium, one towards each extremity. In a short time they become more distinct, and soon a third septum forms, usually median in the spore and between the primary septa. In *B. cylindrica*, other septa subsequently develop but in *D. ravenelii* conidia commonly remain 3-septate, as they often are in nature. The time taken for septa to form varies. In one conidium of *D. ravenelii*, all septa had matured after 10 minutes, while another conidium in the same slide took 35 minutes to reach maturity. Occasionally


31
32
33
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a
b
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d
e
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41
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Figs. 13-42 Septum ontogeny in *Drechslera* s.l. (31) *D. siccans* (32) *D. erythrospila* (33) *D. teres* (34) *D. nobleae*; note thinner wall below primary septum, and below second septum in mature conidia (35) *D. bromi* (36) synchronous differentiation of three septa was observed in maturing conidia of *D. ravenelii*, and rarely a single primary septum formed in an approximately median position.

Although continual observations were not made on developing conidia of *B. crustacea* (P. Henn.) Alcorn, the common presence in young cultures of 2-septate conidia similar to those of *D. ravenelii* indicates that synchronous formation of septa probably occurs in the former species too. Thus three of the ovariicolous species from *Sporobolus*, namely *B. crustacea, B. cylindrica,* and *D. ravenelii*, show the same method of septum ontogeny. *B. australis* Alcorn also occurs in *Sporobolus* inflorescences, and like *D. ravenelii* is commonly 3-septate. However in the former species the primary septum is median, as it is in *B. ovariicola* Alcorn from *Eragrostis* inflorescences (Table 11).

Discussion

The generic types for *Drechslera, Bipolaris* and *Exserohilum* have distinctive patterns of septum development in maturing conidia. In *D. tritici-repentis* and similar species the first septum to form cuts off a cell destined to be the basal cell of the mature conidium. This supports the observations of Luttrell (1963a) on *D. avenacea* and of Shoemaker (1966) on *D. campanulata*. In the species grouped with *B. maydis*, some had a median primary septum as recorded for *D. sorokiniana* by Luttrell (1963a), and in others the primary septum was distinctly submedian as in the generic type for *Bipolaris*.

The increase in size of conidia as they mature would appear to throw doubt on the usefulness of the parameter x as an indicator of the ultimate position for the first formed septum. In species where this septum cuts off the basal cell, the values for a and a_1 were always very similar.

D. leersiae (37) Undet. species from *Zea mays*, conidia with 1, 2, and 3 septa (38) *D. monoceras* (39) *D. ravenelii*, sequence showing development of septa in a conidium formed in agar. (a) aseptate conidium, time (t) = 0; (b) two septa forming simultaneously, t = 27 min; (c) third septum forming in median position, t = 35 min; (d) three septa distinct, t = 48 min; (e) conidiophore beginning to grow past conidium, t = 150 min (40) Undet. species from *Crinum zeylanicum* (41) *B. clavata* (42) *D. australiensis*. Scale represents 25 µm, all figures.

The lower lateral walls of conidia were thick compared with the walls near the apex. It seems probable that most growth occurs in the apical region, and that there is little or no change in length of the basal cell delimited by the primary septum. Thus in these species, x is a reliable guide to the position the first septum will occupy in the mature conidium. Where the primary septum was more or less median, and maturation was accompanied by an increase in size, x is much less likely to accurately indicate where the first septum will ultimately lie. In any case, this is not necessary for this example: there is no predictive element in the statement that the first septum is median in the young conidium. In contrast, the other type of development is defined in such a way that the final position of the primary septum is predicted: it will delimit a basal cell in which no additional septa form.

There is good correlation between primary septum ontogeny and ascal states. In the *D. tritici-repentis* group, 11 species are known to have *Pyrenophora* teleomorphs, and no other ascal state has been recorded. Similarly in the *B. maydis* group, 21 *Cochliobolus* teleomorphs have been demonstrated. The inclusion of *D. pedicellata* introduces heterogeneity here, because it has a *Setosphaeria* ascal state. Teleomorphs in the latter genus are known for five of the species in the *E. turcicum* group, but again the group is heterogeneous because of *D. micropus*, for which a *Cochliobolus* state is recorded (Luttrell 1958).

In addition to primary septum ontogeny, it is suggested that the positions occupied by the second and third septa may be constant. If so this characteristic might be a useful generic criterion in a group where such criteria are not numerous. Thus it is postulated that in *Drechslera*, the second septum is median and the third distal; in *Bipolaris* the second septum cuts off the basal cell and the third is distal; and in *Exserohilum* the second septum is distal and the third median. Conformity with this progression was noted for several species in each group. Additional observations are required on other species to test this hypothesis.

A novel type of septum ontogeny was identified in three species, all ovariicolous parasites of *Sporobolus*. Luttrell (1977) had reported that the first two septa in conidia of *D. ravenelii* were laid down at approximately the same time. Unequivocal evidence in support of this observation was obtained during the work reported here. The pattern of septum development in *D. ravenelii* is as distinct as the different patterns occurring in other species of *Drechslera, Bipolaris,* and *Exserohilum,* in which the developing conidium is divided by a single septum. It might be thought that this distinctive pattern in *D. ravenelii* and similar species could indicate teleomorph connections different to those already known for the three anamorph genera. However a *Cochliobolus* state has been produced for *D. ravenelii* (Alcorn 1981), and thus is predicted also for *B. crustacea* and *B. cylindrica.*

Seven taxa were included in an atypical group because primary septum ontogeny was variable or did not correspond with that in the generic types. In this group, a *Setosphaeria* state is known for *D. pedicellata*, and a *Cochliobolus* teleomorph for *D. tripogonis*. In some conidia of *D. pedicellata* the development of primary and secondary septa was similar to that of *E. turcicum* and other species in the protruding hilum group. The second septum delimits the basal cell in conidia of *D. tripogonis*, as it does in other species with *Cochliobolus* teleomorphs. The same pattern occurred in *B. clavata,* but no ascal state is known for this species. Similarly in *D. nobleae* the second septum delimits the basal cell. However germination behaviour and hilum morphology (see below) in this species suggest affinity with *Drechslera* s. str., rather than with *Bipolaris.* Protothecia are formed in paired cultures of *D. nobleae* and resemble those of *Pyrenophora.* In the unidentified isolate from *Crinum zeylanicum,* the position of the second septum is similar to that of species in the *D. tritici-repentis* group. However hilum morphology and germination behaviour are those of *Bipolaris.* No ascogenous state could be induced in cultures of this taxon.

Primary septum development was used in a key to genera in this group of fungi (Luttrell 1978). *Drechslera* was indicated to have the first-formed septum delimiting the basal cell. The other choice in the couplet, where the primary septum was median in young conidia, led to *Bipolaris, Curvularia,* and *Exserohilum.* My observations on species of *Bipolaris* and *Exserohilum* would not support this interpretation.

HILUM MORPHOLOGY IN SPECIES OF *DRECHSLERA* S.L.

Hilum structure is different in each of the type species for *Drechslera, Bipolaris,* and *Exserohilum.* In this section data are presented on hilum morphology in other species and in unnamed isolates.

In many species of *Drechslera* s.l. the conidial hilum is only about 3-5 µm diameter, and at high magnification the resolution of fine structural detail is not great. Despite this limitation, differences between species were apparent and allowed groups to be established which showed correlation with others as determined by studies on germination and septum ontogeny. Thus, many species allied with *D. tritici-repentis* because of similarity in those characteristics also had the same hilum structure. The largest group was of species in which the hilum was similar to that in *B. maydis*.

In the following descriptions, the hilum is described as seen in optical section unless stated otherwise. Species have been arranged in three groups in which hilum structure is similar to that in *D. tritici-repentis*, *B. maydis*, and *E. turcicum* respectively.

Species with hilum morphology similar to that of *Drechslera tritici-repentis*

In the twenty-one species included in this group (Table 15), the end of the basal cell is always smoothly rounded. The pore is sometimes marked by a small concave depression on the outer face of the wall as was noted in *D. tritici-repentis*. However the hilum structure is more complex internally than is obvious in that species. The darkened elements surround the pore and an intrahilar chamber to which it is connected, forming a cavity which appears roughly T-shaped to deeply V-shaped in optical section (Figs. 43, 45-48). The upper face of the pigmented hilum is sometimes below the inner face of the wall (Figs. 45, 48), and in other instances the hilum is as thick as the cell wall (Figs. 43, 46). Intensity of pigmentation tends to decrease outwards from the pore. A new term is coined here to refer to this form of hilum structure. It is named the 'atrium' type, in reference to the distinctive intrahilar, apparently hollow cavity connected via a pore through the hilum to the exterior of the basal cell.

The hilum in conidia of *D. campanulata* was examined by scanning electron microscopy. A small, slightly ridged pore is visible in the wall at the base of the cell, but there is no change in contour of the wall as occurs with *B. maydis* and *E. turcicum* (Fig. 44). *D. triseptata* is included in this group only tentatively, because the hilum is inconspicuous and few clear examples of the atrium type morphology were detected.

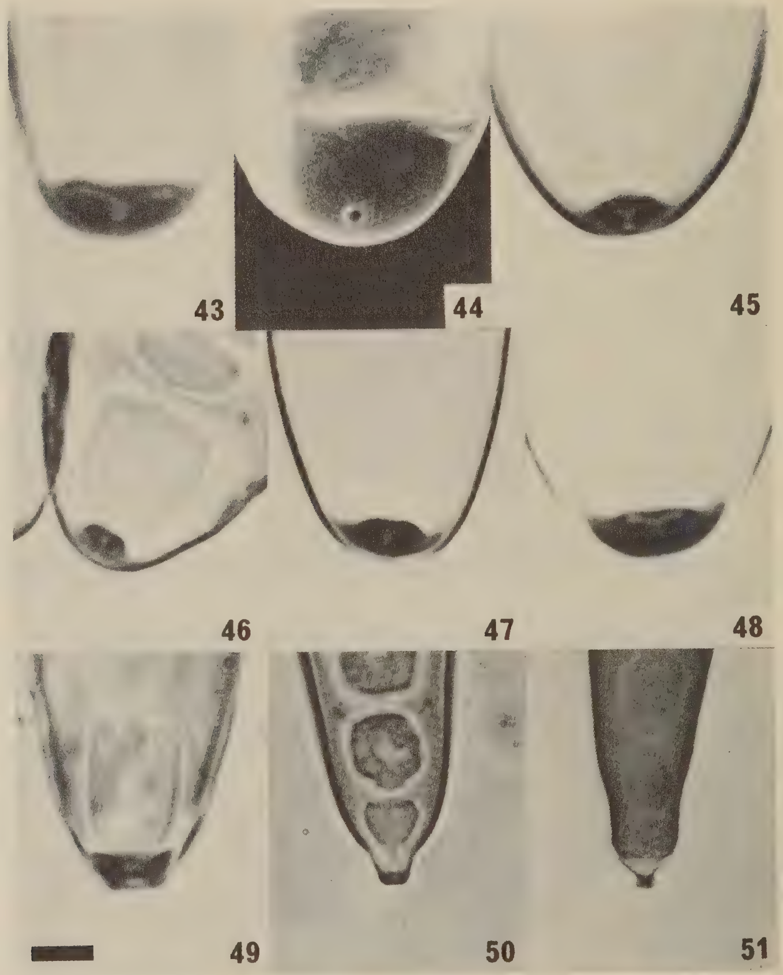
Table 15. Species with conidial hilum structure of the 'atrium' type

andersenii
avenae
biseptata
brizae
bromi
campanulata
catenaria
dactylidis
dematioidea
dictyoides
erythrospila
fugax
graminea
nobleae
phlei
poae
siccans
teres
tetrarrhenae
triseptata
tuberosa

Species with hilum morphology similar to that of *Bipolaris maydis*

Conidial hilum structure was similar to that of *B. maydis* in forty-four species (Table 16), and in all unidentified isolates. There was some variation within and between species, but a truncate protrusion of wall material below the darkened part of the hilum was common to many species assigned here (Fig. 49). In a sample from a single source, the proximity of this darkened section to the wall varied. Some spores had a distinct space between the darkened element and the flattened base, while in others the darkening was closely appressed to the wall across the base, and also up the sides for some distance.

In some species, a structure resembling that of the hilum in the previous group was present, but not in all conidia of any one species. Seen in optical section, the two opposing darkened 'halves' of the hilum were inclined at an acute angle to the base. Joining the outermost point on each was a dark band, and this outlined below it a chamber similar to that described for the species similar to *D. tritici-repentis*. Hila with this form were seen in conidia of *D. chloridis* Alcorn, *B. cylindrica*, *D. cynodontis*, *B. melinidis* Alcorn, *D. sorokiniana*, *D. tripogonis*, *D. urochloae*, and *D. victoriae*.



Figs. 43-51 Hilum morphology in *Drechslera* s.l. (43) *D. campanulata* (44) *D. campanulata*, scanning electron micrograph (45) *D. catenaria* (46) *D. brizae* (47) *D. dactylidis* (48) *D. dictyoides* (49) Undet. species from *Urochloa panicoides* (50) *D. micropus* (51) *D. holmii*. Scale represents 2.5 µm, figs. 43, 44; 3 µm, figs. 45-49; 5 µm, fig. 50; 10 µm, fig. 51.

The conidial hilum in *D. micropus* has sometimes been regarded as protruding. I concur with Leonard and Suggs (1974) and Luttrell (1977) and include this species in the group allied with *B. maydis* on hilum characteristics, because this structure is clearly distinct from the typical protruding hilum (Fig. 50).

Table 16. Species with conidial hilum structure similar to that of *Bipolaris maydis*

australiensis
australis
bicolor
cactivora
chloridis
clavata
coicis
colocasiae
crustacea
cylindrica
cynodontis
dactyloctenii
ellisii
hawaiiensis
homomorphus
incurvata
indica
iridis
kusanoi
leersiae
melinidis
micropus
multiformis
neergaardii
nicotiae
nodulosa
oryzae
ovariicola
papendorfii
peregianensis
perotidis
ravenelii
sacchari
setariae
sorghicola
sorokiniana
spicifera
stenospila
subpapendorfii
tripogonis
urochloae
victoriae
yamadae
zeicola

Species with hilum morphology similar to that of *Exserohilum turcicum*

The conidial hilum was similar to that of *E. turcicum* in six species (Table 17). The enveloping structure around the hilar protrusion in the former species was seen also in some conidia of all other species in this group. It was pronounced on conidia of *D. pedicellata* and *D. holmii* (Luttrell) Subram. & Jain (Fig. 51), and quite inconspicuous in *D. rostrata* and *D. gedarefensis*. Heavily pigmented lateral walls on the hilar protrusion were seen on conidia of *D. monoceras* and *D. gedarefensis*. In the latter species the outer envelope was restricted to a narrow zone abutting the truncate tip of the protrusion. Ellis (1976) had described the conidial hilum in *D. indica* as protruding. There is a basal protrusion, but it is not thickened basally or laterally and has no outer envelope. It has a darkened section similar to that described for *B. maydis*, and for this reason the species has been included in the group allied with that species.

Table 17. Species with conidial hilum structure similar to that of *Exserohilum turcicum*

gedarefensis	pedicellata
holmii	prolatum
monoceras	rostrata

Discussion

Limitations on resolution are imposed by transmitted light bright field microscopy. Despite this it is clear that drawings of hila published by various authors (Drechsler 1923; Nisikado 1928a; Luttrell 1963a, 1964a, 1977; Ellis 1971, 1976) represent a simplification of hilum morphology as it appears under these conditions. Thus the hila of *D. dictyoides*, *D. poae*, *B. maydis*, *D. cynodontis*, and *D. sorokiniana* illustrated by Luttrell (1977) are essentially identical: a circular dark disc perforated centrally by a pore. My observations on these species revealed readily detectable differences between the first two and the remainder. Similarly the structure of the protruding hilum is much more complex than previously described or illustrated. Results from this study cast some doubt on the acceptability of Luttrell's definition (1977) of the protruding hilum in all cases. It often appeared that in species considered to have a protruding hilum, the darkening did not occur on the lateral walls of the protrusion as he claimed.

The distinctions between *Drechslera* and *Bipolaris* in type of hilum, as proposed by Shoemaker (1962, 1966), appear to be soundly based and applicable to a wide range of species. Shoemaker referred to the hilum in the former genus as being included within the contour of the basal cell, and in *Bipolaris* as being slightly protruded. In both genera, conidium ontogeny has been regarded as enteroblastic tretic or 'porogenous' (Ellis 1971; Shoemaker 1959, 1962; Luttrell 1963a, 1964a). The claim has been disputed for the type species of *Bipolaris* by Brotzman et al. (1975). They regarded conidiogenesis in *B. maydis* as being holoblastic, with three wall layers of the conidiophore being involved in the formation of conidia. Ellis and Griffiths (1977) accepted the electron micrographs published by Brotzman et al. as unequivocal evidence for this view. Madelin (1979) placed a different interpretation on these micrographs, and claimed they showed clearly that the major contribution to the wall of the conidium initial in *B. maydis* was from the interior secondary and tertiary wall layers of the conidiogenous cell.

The observations reported here suggest large differences in hilum structure. These appear to be correlated with other characteristics such as method of germination, septum ontogeny, and conidium shape. Whether the types of hilum seen are fundamentally distinct, or merely variations of a basic type, can only be ascertained by additional investigation at ultrastructural level. The flattened conidium base in many of the *Bipolaris* forms may indicate holoblastic conidiogenesis, as reported for *B. maydis* (Brotzman et al. 1975). If so, this may also be the method of spore formation in *Exserohilum* species, where the protruding basal section is distinctly flattened. The smoothly rounded basal contour in conidia of the *Drechslera* type, by analogy, may reflect a different type of ontogeny, namely enteroblastic tretic. There is some controversy over whether the latter method of conidiogenesis occurs in the so-called 'poroconidial fungi' (Carroll & Carroll 1974; Ellis & Griffiths 1977). Cole and Samson (1979) have reviewed the ultrastructural evidence relating to conidiogenesis in fungi producing poroconidia. They admitted that problems in the interpretation of data on wall differentiation had not been resolved completely in these fungi, but decided to regard the poroconidium as a special type of holoblastic propagule. Examination of species such as *D. tritici-repentis* by transmission electron microscopy might provide evidence which would be of help in resolving the existing differences of opinion.

CONIDIUM SHAPE AND COLOUR AND CONIDIOPHORE MORPHOLOGY IN SPECIES OF *DRECHSLERA* S.L.

Observations on these characteristics in the type species of *Drechslera, Bipolaris,* and *Exserohilum* have been presented previously. In this section, data on these attributes in other species are recorded. The terminology for describing shapes of spores given by Ainsworth et al. (1971) is used here, except that 'cylindrical' is not restricted to conidia with a length/width ratio of less than 3:1. No attempt was made to vary shape. It is clear from various reports in the literature that conidial shape in *Drechslera* s.l. can be modified by environmental conditions, especially temperature and nutrition (Nisikado 1929a; Kafi & Tarr 1966; Tarr & Kafi 1968; Trainor & Martinson 1978; Potter et al. 1980).

Conidium shape

Most species were grown on a standard medium, WSA. Some sporulated poorly or not at all on this medium, so they were grown on 15% V-8A (Platt et al. 1977). The ovariicolous species grew poorly and did not sporulate well on these media. They were usually grown on PDA. In these instances conidial morphology was always similar to that of conidia produced on the host. The predominant shape of conidia in each species was determined, and the results are presented in Table 18. Since the curvature of conidia in *Drechslera* s.l. has been given some taxonomic significance, this characteristic also is recorded in the table.

Shape varied widely between species (Table 18), but within species was comparatively constant. Some species had almost perfectly cylindrical straight conidia, while in others conidia were fusoid and curved. Curved cylindrical conidia were uncommon, being seen only in *B. melinidis*. Species with short straight conidia such as *D. hawaiiensis* proved more difficult to assign to a category than others, because of almost continuous variation in shape between cylindrical and ellipsoidal. Data on the unidentified isolates have not been tabulated. Conidia of all taxa were fusoid and curved, except in the isolates from *Crinum zeylanicum* and *Panicum pygmaeum* R.Br. (77108a) in which conidia were often cylindrical. Some straight conidia also occurred in these two isolates.

Table 18. Conidium shape and curvature, and roughening of conidiogenous nodes on conidiophores in species of *Drechslera* s.l.

Species	Shape†	Nodes†	Species	Shape	Nodes
andersenii	cyl	-	micropus	ell#	+
australiensis	cyl-ell	-	monoceras	fus#	-
australis	fus	-	multiformis	ell-fus	+
avenae	cyl	-	neergaardii	ell	+
bicolor	fus	+	nicotiae	ell	-
biseptata	obo	-	nobleae	obc	-
brizae	ell	-	nodulosa	ov-obc	-
bromi	cyl	-	oryzae	fus*	+
cactivora	obc-fus	-	ovariicola	cl-fus*	+
campanulata	cyl-obc	-	papendorfii	ell*	+
catenaria	obc	-	pedicellata	fus	-
chloridis	fus*	+	peregianensis	fus*	+
clavata	cl-fus*	+	perotidis	fus	-
coicis	obc-ell*	-	phlei	obc	-
colocasiae	fus#	-	poae	subcyl	-
crustacea	subcyl-fus#	-	prolatum	cyl-fus#	+
cylindrica	subcyl-fus#	-	ravenelii	ell-obc	-
cynodontis	fus#	+	rostrata	obc#	+
dactylidis	cyl	-	sacchari	fus*	+
dactyloctenii	cyl-fus	-	setariae	fus*	+
dematioidea	obo	±	siccans	cyl	-
dictyoides	cyl-obc	-	sorghicola	fus*	+
ellisii	ell#	-	sorokiniana	fus-obc#	+
erythrospila	cyl	-	spicifera	cyl-ell	-
fugax	cyl	-	stenospila	fus*	+
gedarefensis	cl#	+	subpapendorfii	ell*	-
graminea	cyl	-	teres	cyl	-
hawaiiensis	cyl-ell	-	tetrarrhenae	cyl	-
holmii	fus#	+	tripogonis	cyl-fus#	+
homomorphus	cyl-ell	+	triseptata	cyl-ell	+
incurvata	fus*	+	tuberosa	cyl	-
indica	ell	-	urochloae	fus-obc#	+
iridis	ell	-	victoriae	fus#	+
kusanoi	ell	-	yamadae	fus-obc#	±
leersiae	fus*	+	zeicola	cyl-fus#	+
melinidis	cyl-fus*	+			

† Abbreviations and symbols: cl - clavate; cyl - cylindrical; ell - ellipsoidal; fus - fusoid; obc - obclavate; obo - obovoid; ov - ovoid; subcyl - subcylindrical; * - conidia curved; # - conidia straight or curved; unmarked - conidia straight; + nodes roughened; - nodes smooth; ± slightly roughened some nodes only.

Discussion

Conidium shape in named species was similar in each instance to that reported in the literature. This was expected. Although there are capabilities for variation in each species, these are not unlimited. If they were, the morphological approach to taxonomy at species rank would not be as useful a method as it so obviously is in many groups of fungi.

Correlations of shape with other characteristics are strong. Species with straight cylindrical conidia usually show lateral emergence of basal germ tubes, basal primary septum ontogeny, and the atrium type of hilum. Species with curved, fusoid conidia exhibit semiaxial germ tube growth from the basal cell, have a truncate hilum of the *B. maydis* type, and approximately median primary septum development. Straight ellipsoidal to fusoid conidium types mostly seem best grouped with the species having curved conidia. An exception here is *D. brizae*. The conidia of this species commonly are ellipsoidal, but it undoubtedly belongs in the group of species allied with *D. tritici-repentis*.

Criteria other than shape would have to be considered in some species if a grouping of similar forms were required. For example in *D. biseptata* and *D. dematioidea*, the obovoid shape might suggest affinities with *Bipolaris* (Nisikado 1929a), but characteristics of the hilum, germination behaviour, and primary septum development indicate otherwise. Conidia of *Exserohilum prolatum* and *D. tripogonis* are often cylindrical, yet neither species is related to others with cylindrical conidia. The latter have teleomorphs in *Pyrenophora*, whereas perfect states for *E. prolatum* and *D. tripogonis* are in *Setosphaeria* and *Cochliobolus* respectively.

Curvature of the conidia is pronounced in some species. Teleomorphs in *Cochliobolus* are known for some of these species, for example *B. maydis*, *D. chloridis* and *D. oryzae*. This ascomycete genus, however, also includes species in which the anamorphs have straight, more or less cylindrical conidia, for example *C. hawaiiensis* Alcorn and *C. spicifer* Nelson. Degree of curvature can be modified by environmental conditions, and some species with curved conidia can be induced to produce mostly straight forms. Deighton (1976) considered degree of conidial curvature an unsatisfactory generic criterion for separating

Helicomina from *Pseudocercospora*, and placed the former name in synonymy. In some species of *Pseudocercospora*, the conidia vary from almost straight to strongly curved. In *Curvularia*, which appears to be closely related to some of the *Drechslera*-like fungi, conidia are straight in some species and curved in others (Ellis 1971). Some other hyphomycete genera with phragmospores which may be straight or curved are *Corynespora*, *Stenella*, *Phaeoisariopsis*, and *Stigmina*.

Conidium colour

Luttrell (1964a, 1977) used colour of conidia as a generic characteristic. He stated that conidia were subhyaline or pale brown in *Drechslera*, and darker brown in *Bipolaris*. Shoemaker (1966) also suggested that colour could be used to help separate the two taxa, but warned of exceptions to the general rule.

I believe there are sufficient exceptions to make conidium colour unacceptable as a taxonomic criterion at generic rank. Various reports indicate condsiderable variation in colour between and within species. For example Kafi and Tarr (1966) examined the effects of culture media on characteristics of growth, sporulation, and conidial morphology in five *Helminthosporium* species. They found that conidial colour was affected by the medium used, being lighter on asparagine agar and glucose peptone agar than on PDA, malt agar, corn meal agar, or Czapek Dox agar. Also, in a single basal medium, increases in glucose concentration led to increased pigmentation in conidia of the species studied. Tarr and Kafi (1968) reported that increasing nitrogen concentration in asparagine agar produced darker conidia in *H. sorghicola* Lefebvre & Sherwin, and paler conidia in the other species studied by Kafi and Tarr. Cultures with urea as the nitrogen source produced darker conidia than cultures incorporating other sources such as sodium nitrite or asparagine. Conidia from cultures on alkaline media were darker than those from cultures on acid media. Similarly, Trainor and Martinson (1978) reported that conidia of *B. maydis* from cultures on PDA, V-8A, and asparagine agar were darker than those from maize leaf or ground maize leaf agar culture. Harding (1975) found that conidia of *D. sorokiniana*, *B. maydis*, *D. zeicola*, and *D. setariae* were darker at pH 9 than at pH 4. Conidia of *D. sorokiniana* and *D. zeicola* were also darker on media containing 20 g/litre or 30 g/litre of sucrose than on media with lesser amounts.

Personal observations on colour of conidia in a number of species support Shoemaker's statement that there are exceptions to the generalization proposed by Luttrell. Thus some species allied with *Drechslera* on other characteristics have mid brown to dark brown conidia, for example *D. campanulata*, *D. dematioidea*, *D. fugax*, *D. poae*, and *D. tetrarrhenae*. Conversely some *Bipolaris* forms have quite pale conidia, for example *B. australis*, *D. cynodontis*, *D. ravenelii* and *D. tripogonis*. Colour also varies in a single collection, and between collections of a single species. Conidia of *D. ravenelii* from young freely-sporulating colonies on the host are pale olivaceous to golden brown, while those on older weathered inflorescences are dark reddish brown. Conidia of *D. incurvata* from culture are darker than those from lesions on the host.

Colour of conidia was not considered further in this study because of the lack of correlation with other characteristics in several species. Its use as a taxonomic criterion at the rank of genus would appear to be limited.

Conidiophore morphology

Conidiophores of *Drechslera* species occur singly, or are divergent in small fascicles. They are cylindrical, often with the basal cell inflated to a more or less hemispherical, doliiform, or campanulate shape. In many conidiophores width just above the swollen base is slightly greater than at the apex. Colour varies from pale brown to dark reddish brown, and in a single conidiophore commonly becomes paler towards the apex. After production of the first conidium, the conidiophore resumes growth by a sub-terminal protrusion. The amount of growth before the next conidium is formed varies widely between species. It is usually large in *D. oryzae* and small in *D. spicifera*. In many species the sporogenous nodes are geniculate. This is especially noticeable in species with widely spaced conidiogenous nodes. In other species many conidia are produced on very short increments of the conidiophore, and in these the conidiogenous segment becomes more or less torsive. Where widely spaced fertile nodes occur on older parts of the conidiophore, the inter-nodal distance usually decreases as more conidia are formed.

Conidiophores in the type species of *Drechslera*, *Bipolaris*, and *Exserohilum* are very similar in general morphology. The only difference noted which might be considered a possible generic characteristic was roughening of sporogenous nodes. It was absent in *D. tritici-repentis* and *E. turcicum*, and present in *B. maydis* (Fig. 18). Twenty-nine of the named species had distinctly roughened conidiogenous nodes (Table 18). All unnamed isolates except those from *Crinum zeylanicum*, *Eragrostis brownii* (Kunth) Nees ex Steudel, *E. pilosa* (L.) Beauv., and *Sporobolus* sp. (appendix part 2) had roughened nodes. The warts which comprised the roughening were prominent in some species, for example *D. multiformis* and *D. tripogonis*. In certain species some of the conidiogenous nodes were roughened slightly and some were not. *D. dematioidea* and *D. yamadae* (Nisik.) Subram. & Jain are examples of species in which this variation exists.

Discussion

The characteristic of roughened conidiogenous nodes on conidiophores of these fungi has been reported rarely. Cole (1973) has published a scanning electron micrograph showing it in *D. sorokiniana*. I reported the characteristic in the description of *D. chloridis* (Alcorn 1976), and the illustration of *D. sorghicola* by Ellis (1971) shows a roughened terminal node on a secondary conidiophore. Ornamented conidiogenous nodes occur in some other hyphomycete genera, for example *Stemphylium*.

Only two species allied with the *Drechslera* s. str. group were found with roughened nodes, namely *D. dematioidea* and *D. triseptata*. In the former species the ornamentation was slight, and not present on all nodes. It was less obvious on an authentic specimen of *D. triseptata* (ex BPI) than on a culture obtained in Queensland. The characteristic was noted on species of both *Bipolaris* and *Exserohilum*. Species of the *Bipolaris* type in which the conidial scars are closely spaced on a more or less torsive sporogenous segment of the conidiophore did not have the nodes roughened, whereas those with widely separated scars often did.

There is a tendency for conidiogenous nodes to be smooth in species similar to *D. tritici-repentis* in other characters, and for nodes to be roughened in species sharing some characteristics with *B. maydis*. The exceptions in both instances, especially the latter, prohibit the use of conidiophore morphology as a taxonomic criterion at generic rank.

TELEOMORPHS CORRELATED WITH *DRECHSLERA, BIPOLARIS* AND *EXSEROHILUM*

The type species for the genera *Drechslera, Bipolaris* and *Exserohilum* have each been shown to be connected with a different teleomorph genus. *D. tritici-repentis* is the anamorph of *Pyrenophora tritici-repentis* (Diedicke 1902, 1903; Drechsler 1923), *B. maydis* is the anamorph of *Cochliobolus heterostrophus* (Drechsler) Drechsler (Drechsler 1925, 1934), and *E. turcicum* is the anamorph of *Setosphaeria turcica* (Luttrell) Leonard & Suggs (Luttrell 1958; Leonard & Suggs 1974). Other species variously assigned among the three anamorph genera have also been shown to have teleomorphs in *Pyrenophora, Cochliobolus,* or *Setosphaeria* (Table 19). A fourth ascomycete genus, *Pseudocochliobolus*, has been proposed to accommodate three species previously described in *Cochliobolus* and the newly discovered teleomorphs of *D. coicis* (Tsuda et al. 1977) and *D. australiensis* (Tsuda & Ueyama 1981). I have advanced reasons elsewhere for reducing this name to synonymy with *Cochliobolus* (Alcorn 1983a).

The anamorph-teleomorph connections demonstrated so far in this group show correlations between conidial morphology and ascal`state genus. Thus some of the species assigned to *Drechslera* are known to have *Pyrenophora* teleomorphs, some *Bipolaris* species are connected with *Cochliobolus* states, and the known teleomorphs for *Exserohilum* species are in *Setosphaeria.* Based on these correlations, it has been suggested that anamorph morphology is predictive and that connections identified subsequently will be *Drechslera-Pyrenophora, Bipolaris-Cochliobolus,* and *Exserohilum-Setosphaeria* (Leonard & Suggs 1974; Luttrell 1978). I have tested the predictive aspects of anamorph classification by attempting to produce teleomorphs for species where no connection had been demonstrated previously. Nine new ascal states referable to *Cochliobolus* were produced, and one new *Setosphaeria.* In six of these connections, the anamorphs had been described previously. The remaining four were considered to be undescribed in both states, and new names have been proposed elsewhere. These ten new connections are listed below.

Table 19. Teleomorphs of *Drechslera, Bipolaris,* and *Exserohilum* species

Anamorph†	Teleomorph†	Reference
B. australiensis	C. australiensis	Tsuda & Ueyama 1981
D. avenacea	P. chaetomioides*	Shoemaker 1962
D. avenae	P. avenae*	Ito 1930
B. bicolor	C. bicolor	Paul & Parbery 1966
D. bromi	P. bromi	Drechsler 1923
D. campanulata	P. semeniperda	Shoemaker 1966
B. chloridis	C. chloridis	Alcorn 1978a
B. coicis	C. nisikadoi	Tsuda, Ueyama & Nishihara 1977
B. cynodontis	C. cynodontis	Nelson 1964a
D. dactylidis	P. dactylidis	Ammon 1963
B. dactyloctenii	C. dactyloctenii	Alcorn 1982a
D. dictyoides	P. dictyoides	Paul & Parbery 1968
B. ellisii	C. ellisii	Alcorn 1983b
D. erythrospila	P. erythrospila	Paul 1972
D. graminea	P. graminea	Ito 1930
B. hawaiiensis	C. hawaiiensis	Alcorn 1978a
E. holmii	S. holmii	Luttrell 1963b
B. homomorphus	C. homomorphus	Luttrell & Rogerson 1959
B. kusanoi	C. kusanoi	Nisikado 1928b
B. maydis	C. heterostrophus	Drechsler 1925, 1934
B. melinidis	C. melinidis	Alcorn 1982a
B. micropus	Cochliobolus sp.	Luttrell 1958
E. monoceras	S. monoceras	Alcorn 1978b
B. nodulosa	C. nodulosus	Luttrell 1957
B. oryzae	C. miyabeanus	Ito & Kuribayashi 1927
E. pedicellatum	S. pedicellata	Nelson 1965
B. peregianensis	C. peregianensis	Alcorn 1982a
B. perotidis	C. perotidis	Alcorn 1982a
E. prolatum	S. prolata	Leonard & Suggs 1974
B. ravenelii	C. ravenelii	Alcorn 1981
E. rostratum	S. rostrata	Leonard 1976
B. setariae	C. setariae	Ito 1930
D. siccans	P. lolii	Dovaston 1948
B. sorokiniana	C. sativus	Kuribayashi 1929
B. spicifera	C. spicifer	Nelson 1964b
B. stenospila	C. stenospilus	Matsumoto & Yamamoto 1936
D. teres	P. teres	Drechsler 1923
D. tetrarrhenae	P. tetrarrhenae	Paul 1971
B. tripogonis	C. tripogonis	Alcorn 1981
D. tritici-repentis	P. tritici-repentis	Drechsler 1923
D. tuberosa	P. japonica	Ito 1930
E. turcicum	S. turcica	Luttrell 1958
B. victoriae	C. victoriae	Nelson 1960
B. zeicola	C. carbonum	Nelson 1959
Bipolaris sp.	C. sporoboli	Castellani 1951
Bipolaris sp.	C. tritici	Dastur 1942
Drechslera sp.	P. phaecomes	Shoemaker 1961
Exserohilum sp.	S. khartoumensis	El Shafie & Webster 1981

† B = *Bipolaris*, C = *Cochliobolus*, D = *Drechslera*, E = *Exserohilum*, P = *Pyrenophora*, S = *Setosphaeria*.

* Shoemaker (1962) regards *D. avenae* as a synonym of *D. avenacea*, and *P. avenae* as a synonym of *P. chaetomioides*.

Teleomorph	Anamorph	Reference
Cochliobolus chloridis	Bipolaris chloridis	Alcorn 1978a
C. dactyloctenii	B. dactyloctenii	Alcorn 1982a
C. ellisii	B. ellisii	Alcorn 1983b
C. hawaiiensis	B. hawaiiensis	Alcorn 1978a
C. melinidis	B. melinidis	Alcorn 1982a
C. peregianensis	B. peregianensis	Alcorn 1982a
C. perotidis	B. perotidis	Alcorn 1982a
C. ravenelii	B. ravenelii	Alcorn 1981
C. tripogonis	B. tripogonis	Alcorn 1981
Setosphaeria monoceras	Exserohilum monoceras	Alcorn 1978b

These additional data clearly support the contention that teleomorph connections can be predicted by considering various aspects of anamorph morphology and biology. The recently described *S. khartoumensis* El Shafie & Webster (El Shafie & Webster 1981) has an anamorph referable to *Exserohilum*. Hilum structure is similar to that of *E. turcicum*, but I have not been able to determine septum ontogeny in conidia of this species.

DISCUSSION

The fungi discussed in this paper caused diseases, which are often important economically, in a wide range of gramineous hosts. They have also been implicated in human and animal diseases. Their classification is therefore of more than academic interest. Continuing uncertainty about generic taxonomy in the group places a burden on users of the classification because it allows for a multiplicity of binomials to be applied to one species, complicated in this instance by teleomorph nomenclature. The use of several names for a species hampers recall from a system where binomials are key words in the organization, storage and retrieval of information. Another important function, that of allowing generalizations and predictions, is important in many applied fields. The predictive function is defeated by a scheme which obscures relationships by using too few categories. The convenience of a single generic name for the fungi under discussion is far outweighed by the greater accuracy inherent in a polynomial system. The evidence presented in this paper offers strong support for the recognition of three genera of anamorphs for fungi with ascogenous states in *Pyrenophora*, *Cochliobolus*, and *Setosphaeria*. These anamorph genera are *Drechslera*, *Bipolaris*, and *Exserohilum* respectively. As is true in other groups of fungi, no single character is of paramount importance in separating taxa. Rather, there is a set of correlated characters for each genus which, considered together, allows disposition of unidentified species. These characters are summarized below for the three accepted genera of anamorphs.

Drechslera: conidia commonly more or less cylindrical, straight; germinating from polar and intermediate cells, or polar cells only; basal germ tube usually originating well clear of hilum, and growing at a wide angle to the longitudinal axis; hilum of the atrium type, and inserted within a rounded basal contour; first conidial septum delimiting the basal cell of the mature conidium, second septum more or less median in the upper cell, the third septum distal; conidiogenous nodes smooth.

Bipolaris: conidia commonly fusoid, straight or curved; germinating principally from one or both polar cells; basal germ tube originating close to the hilum, and growing semiaxially; hilum associated with a slightly protruding, truncate section of the wall, and often visible as two dark lenticular spots in optical section; first conidial septum median to submedian, second septum delimiting the basal cell of the mature conidium, the third septum distal; conidiogenous nodes rough or smooth.

Exserohilum: conidia fusoid to cylindrical or obclavate, straight or curved; germinating from polar cells; basal germ tube semiaxial from near the hilum, rarely lateral; hilum protruding strongly, commonly with a complex double-walled structure; first conidial septum submedian, second septum in distal third of maturing conidium, the third septum median; conidiogenous nodes rough or smooth.

Many taxonomic groups contain intermediates or atypical representatives, and this is true of fungi in the *Drechslera-Bipolaris-Exserohilum* complex. In the first genus, *D. nobleae* has conidium shape and colour, hilum structure, and germination similar to other members of *Drechslera*, but primary septum ontogeny is atypical and more like that in some *Bipolaris* species. In the latter genus, septum ontogeny in *D. ravenelii* and some other species on *Sporobolus* inflorescences is not like that of others in the group. In *Exserohilum* as delimited by Leonard and Suggs (1974) there is remarkable uniformity in the various characteristics examined. However some of these criteria are shared by species of other genera. Thus septum ontogeny in *D. indica* is like that in *Exserohilum* species, but other characteristics point to *Bipolaris* as a more appropriate genus for this species. Ellis (1976) recorded *D. indica* as having a protruding hilum, but observations during this study suggest a different interpretation. Septum ontogeny in *D. micropus* is also like that in *Exserohilum* species, but the species was excluded from the genus by Leonard and Suggs (1974) on the grounds of hilum structure, an action supported by Luttrell (1977) and in this paper. Despite these and other examples where correlation is not complete, the bulk of the data obtained supports the conclusion that the genera *Drechslera*, *Bipolaris*, and *Exserohilum* should be recognized.

Ellis (1976) advocated the use of *Drechslera* s.l. for the fungi under discussion because teleomorphs were unknown for many 'critical species' and because 'even the experts have great difficulty in deciding whether they should be in *Drechslera*, *Bipolaris* or some other genus'. Thus *D. brizae* was placed in *Eu-Helminthosporium* by Nisikado (1929a) and in *Bipolaris* by Shoemaker (1959), and the correct generic position for *D. campanulata* was not immediately evident to various workers. However such errors in generic choice probably take place only because insufficient characteristics or specimens are studied. Use of *Drechslera* s.l. because some species are difficult to place, or because intermediates occur, is no longer supportable. Continued adherence to that proposition will obscure relationships, and dilute the usefulness of the classification in terms of prediction and information retrieval. Lack of knowledge of teleomorph connections for many species is not regarded as a barrier to the use of three anamorph genera. The perfect state correlations now known for this group of fungi clearly indicate that *Bipolaris* species are more closely related to each other than to species of *Drechslera* s. str.. In other examples where segregates have been removed from heterogeneous anamorph genera, an absence of known teleomorph connections has not proved inhibitory (Ellis 1971; Deighton 1973; Hughes 1958).

ACCEPTED BINOMIALS AND NEW COMBINATIONS IN *DRECHSLERA*, *BIPOLARIS*, AND *EXSEROHILUM*

Earlier in this paper it was concluded that retention of three genera for fungi in *Drechslera* s.l. is justified and desirable. Some new combinations must therefore be made, and accepted binomials are shown in Table 20. This list also includes names of recently described *Bipolaris* species (Alcorn 1982a, 1982b). It does not include all the specific epithets ever applied to the 'graminicolous *Helminthosporium* species'. Cultures for some of these species were not available to me, and therefore all generic criteria could not be determined for them.

Table 20. Accepted binomials and new combinations in *Drechslera*, *Bipolaris*, and *Exserohilum* (listed alphabetically by specific epithet)

Drechslera andersenii Scharif
Bipolaris australiensis (M.B. Ellis) Tsuda & Ueyama
Bipolaris australis Alcorn
Drechslera avenae (Eidam) Scharif
Bipolaris bicolor (Mitra) Shoem.
Drechslera biseptata (Sacc. & Roum.) Richardson & Fraser
Drechslera brizae (Nisik.) Subram. & Jain
Drechslera bromi (Died.) Shoem.
Bipolaris cactivora (Petrak) comb. nov.
  Helminthosporium cactivorum Petrak, Gartenbauwissenschaft 5: 266, 1931.
Drechslera campanulata (Lév.) Sutton
Drechslera catenaria (Drechsler) Ito
Bipolaris chloridis (Alcorn) Alcorn
Bipolaris clavata Alcorn
Bipolaris colocasiae (Tandon & Bhargava) comb. nov.
  Drechslera colocasiae Tandon & Bhargava, Curr. Sci. 49 (2): 75, 1980 (as *colocaseae*)
Bipolaris crustacea (P. Henn.) Alcorn
Bipolaris cylindrica Alcorn
Bipolaris cynodontis (Marig.) Shoem.
Drechslera dactylidis Shoem.
Bipolaris dactyloctenii Alcorn
Drechslera dematioidea (Bubák & Wrób.) Subram. & Jain
Drechslera dictyoides (Drechsler) Shoem.
Bipolaris ellisii (Danquah) Alcorn
Drechslera erythrospila (Drechsler) Shoem.

Drechslera fugax (Wallr.) Shoem.
Exserohilum gedarefensis (El Shafie) comb. nov.
  Drechslera gedarefensis El Shafie, Trans. Br. mycol. Soc. 74: 437, 1980.
Drechslera graminea (Rabenh. ex Schlecht.) Shoem.
Bipolaris hawaiiensis (M.B. Ellis) Uchida & Aragaki
Exserohilum holmii (Luttrell) Leonard & Suggs
Bipolaris homomorphus (Luttrell & Rogerson) Subram. ex Alcorn
Bipolaris incurvata (Ch. Bernard) comb. nov.
  Helminthosporium incurvatum Ch. Bernard, Bull. Dep. Agric. Indes. neerl. 2: 31, 1906.
Bipolaris indica Rai, Wadhwani & Tewari
Bipolaris iridis (Oud.) Dickenson
Bipolaris kusanoi (Nisik.) Shoem.
Bipolaris leersiae (Atk.) Shoem.
Bipolaris maydis (Nisik. & Miyake) Shoem.
Bipolaris melinidis Alcorn
Bipolaris micropus (Drechsler) Shoem.
Exserohilum monoceras (Drechsler) Leonard & Suggs
Bipolaris multiformis (Jooste) comb. nov.
  Drechslera multiformis Jooste, Bothalia 11: 511, 1975.
Bipolaris neergaardii (Danquah) comb. nov.
  Drechslera neergaardii Danquah, Trans. Br. mycol. Soc. 64: 545, 1975.
Bipolaris nicotiae (Mouchacca) comb. nov.
  Drechslera nicotiae Mouchacca, Rev. Mycol. 38: 108, 1974.
Drechslera nobleae McKenzie & Matthews
Bipolaris nodulosa (Berk. & Curt.) Shoem.
Bipolaris oryzae (B. de Haan) Shoem.
Bipolaris ovariicola Alcorn
Bipolaris papendorfii (van der Aa) comb. nov.
  Curvularia papendorfii van der Aa, Persoonia 5: 45, 1967.
Exserohilum pedicellatum (Henry) Leonard & Suggs
Bipolaris peregianensis Alcorn
Bipolaris perotidis Alcorn
Drechslera phlei (Graham) Shoem.
Drechslera poae (Baudys) Shoem.
Exserohilum prolatum Leonard & Suggs
Bipolaris ravenelii (Curt.) Shoem.
Exserohilum rostratum (Drechsler) Leonard & Suggs
Bipolaris sacchari (Butler) Shoem.
Bipolaris setariae (Saw.) Shoem.
Drechslera siccans (Drechsler) Shoem.

Bipolaris sorghicola (Lefebvre & Sherwin) comb. nov.
  Helminthosporium sorghicola Lefebvre & Sherwin, Mycologia 40: 714, 1948.
Bipolaris sorokiniana (Sacc.) Shoem.
Bipolaris spicifera (Bain) Subram.
Bipolaris stenospila (Drechsler) Shoem.
Bipolaris subpapendorfii (Mouchacca) comb. nov.
  Drechslera subpapendorfii Mouchacca, Rev. Mycol. 38: 107, 1974.
Drechslera teres (Sacc.) Shoem.
Drechslera tetrarrhenae Paul
Bipolaris tripogonis (A.S. Patil & V.G. Rao) Alcorn
Drechslera triseptata (Drechsler) Subram. & Jain
Drechslera tritici-repentis (Died.) Shoem.
Drechslera tuberosa (Atk.) Shoem.
Exserohilum turcicum (Pass.) Leonard & Suggs
Bipolaris urochloae (Putterill) Shoem.
Bipolaris victoriae (Meehan & Murphy) Shoem.
Bipolaris yamadae (Nisik.) Shoem.
Bipolaris zeicola (Stout) Shoem.

All undetermined isolates listed in part 2 of the appendix belong in *Bipolaris*. Hilum morphology and conidium shape in *D. euphorbiae* (Hansf.) M.B. Ellis (IMI 161577), *D. heveae* (Petch) M.B. Ellis (IMI 136064) and *D. musae-sapientum* (Hansf.) M.B. Ellis (IMI 8876) suggest affinity with *Bipolaris* for these species also. The names have not been transferred pending examination of cultures.

HOST ASSOCIATIONS IN *DRECHSLERA*, *BIPOLARIS*, AND *EXSEROHILUM*

Many of the cultures used in this investigation were from grasses collected in south-eastern Queensland, defined by Tothill and Hacker (1973) as an area east of a line joining Rockhampton and Goondiwindi. Isolations were made from any lesions on grass leaves on which no fungal sporulation was evident. A large collection of cultures of *Drechslera* s.l. was accumulated, and a representative set of named species and unnamed isolates was drawn from this collection for tests of generic characteristics. A large proportion of the taxa so examined were referable to *Bipolaris* on the basis of the generic criteria adopted. Species of *Drechslera* s. str. were isolated infrequently.

This skewed distribution in favour of *Bipolaris* appears to be correlated strongly with the occurrence of certain grass taxa in the study region, and the comparative absence of others, as discussed below.

A punch card host-fungus index was prepared which allowed hosts to be sorted according to suprageneric groups. These data were based on two sources, namely herbarium specimens and literature references. The former are deposited in herb. BRIP, many having been collected during the present survey but some originating from earlier work. Most are from eastern Australia, but a proportion represent cultures from extra-Australian sources, or slides made from specimens borrowed from other herbaria. The second source was restricted to major taxonomic treatments such as those of Drechsler, Shoemaker, Nisikado, Ellis, and Leonard and Suggs. These are regarded as having a high degree of acceptability in terms of accurate determinations of fungal identity when compared with some other reports.

Clifford and Watson (1977) divided the Poaceae (Gramineae) into 11 major series, for most of which informal group names were employed. The series recognized were: Andropogonoids, Eu-panicoids, Chloridoids (Eragrostoids), Aristideae, Arundinoids, Danthonioids, Stipeae, Festucoids (Pooids), Oryzoids, Centostecoids (Centothecoids) and Bambusoids. Six genera were in an unclassified residue not referable to any series. These groups were used in the analysis of host preferences reported in this section.

The data (Table 21-23) reveal strong host preferences at group level for the genera *Drechslera* and *Bipolaris*. Species of *Drechslera* are usually associated with the festucoid series of grasses, while *Bipolaris* species commonly occur on hosts in the andropogonoid, eu-panicoid, and chloridoid groups. The last three groups are also more commonly hosts to *Exserohilum* species than are other groups (Tables 21, 24). Thus the predominance of *Bipolaris* species found in samples of grasses from south-east Queensland can be explained in terms of the grass flora of that area. Tothill and Hacker (1973) listed 103 genera, of which approximately 70% are andropogonoid, eu-panicoid, or chloridoid. This in turn reflects the distribution of major grass groups in terms of climate. The last-named groups are grasses of tropical and subtropical regions while the festucoids tend strongly to be restricted to temperate climates, especially in the northern hemisphere. These host associations are similar to those reported by Nishihara (1971). He classified the Japanese *Helminthosporium* species into the subgenera *Cylindro-Helminthosporium* and *Eu-Helminthosporium*, and found that the former occurred only on the Festucoideae, and the latter principally on the Oryzoideae, Eragrostideae, and Panicoideae. The only occurrence of a member of *Eu-Helminthosporium* on festucoid grasses was by *B. sorokiniana* on *Arrhenatherum*, *Bromus*, *Holcus*, *Hordeum*, and *Triticum*. Australian collections of this fungus showed a similar broad host range.

Table 21. Numbers of species of *Drechslera*, *Bipolaris*, and *Exserohilum* recorded on different groups of grasses

Grass group†		*Drechslera*	*Bipolaris**	*Exserohilum*
Andropogonoid	1a	2	17	7
Eu-panicoid	1b	3	22	3
Chloridoid	2	2	27	2
Aristideae	3	0	0	1
Arundinoid	4	0	2	0
Danthonioid	5	2	0	0
Stipeae	6	0	2	1
Festucoid	7	24	9	3
Oryzoid	8	2	7	2
Centostecoid	9	0	0	0
Bambusoid	10	1	0	0
Unclassified	11	1	3	1

† Clifford and Watson (1977)
* Undetermined species are not included

Some species from each fungal genus appear to be restricted to a particular genus of grasses. Examples are *D. bromi* (on *Bromus*), *D. fugax* (*Agrostis*), *D. graminea* (Rabenh. ex Schlecht.) Shoem., *D. teres* (*Hordeum*), *B. chloridis* (Alcorn) Alcorn (*Chloris*), *B. ravenelii* (Curt.) Shoem., *B. cylindrica* (*Sporobolus*), *B. miyakei* (Nisik.) Shoem.

(Eragrostis), and *E. prolatum (Zea)*. Other species have been recorded on so many hosts that they can be regarded as plurivorous, for example *D. tritici-repentis* (on 16 genera of grasses), *B. hawaiiensis* (M.B. Ellis) Uchida & Aragaki (18), *B. maydis* (10), *B. sorokiniana* (Sacc.) Shoem. (41), *B. zeicola* (Stout) Shoem. (19), and *E. rostratum* (Drechsler) Leonard & Suggs (39). The ovariicolous *Bipolaris* species are host-restricted, being found only on chloridoid grasses: *Eragrostis, Sporobolus, Thellungia,* and *Tripogon* (Alcorn 1982b). These habitat and host preferences suggest a specialized group of species which have evolved differently from other *Bipolaris* species. Most other species occur principally on grass leaves or stems and never attack ovaries, although sometimes other parts of the inflorescence such as lemma, palea, and rachis may be infected, for example *B. melinidis* on *Melinis minutiflora* Beauv. (pers. obs.), *B. kusanoi* (Nisik.) Shoem. on *Eragrostis major* Host. (Nisikado 1928b). In contrast, the ovariicolous species have never been recorded as infecting leaves. Cultures of the ovariicolous species generally grew well and sporulated abundantly on PDA but not on WSA. The latter medium was conducive to sporulation by foliicolous species, while restricting development of aerial mycelium. On PDA, many of the leaf-infecting species produced an abundance of aerial mycelium at the expense of conidia. The conidia formed on PDA often differed morphoolgically from those formed on wheat straw. On the latter medium, conidia were usually more like those produced on the natural host, especially in *Bipolaris* species with comparatively large, curved conidia. These differences in sporulation behaviour between foliicolous and ovariicolous *Bipolaris* species may reflect nutritional differences in the substrate niches usually exploited.

CONCLUSION

In the presentation of a rationale for undertaking this investigation, reference was made to a lack of experimental evidence concerning generic limits in the fungi disposed in *Drechslera* s.l. The results presented in this paper have largely removed this deficiency, and have refined and added criteria by which unidentified taxa can be judged in the future. The characteristics which have been used to separate the genera are few, and are comparatively easily determined from dried specimens and by simple cultural manipulation. However, these seemingly minor

Table 22. Host ranges in the Poaceae for species of *Drechslera*

Fungus	Grass hosts (by groups*)											
	1a	1b	2	3	4	5	6	7	8	9	10	11
andersenii								+				
avenacea								+				
avenae								+				
biseptata								+				
brizae								+				
bromi								+				
campanulata						+		+				
catenaria	+							+				
dactylidis								+				
dematioidea		+				+		+				
dictyoides		+						+				
erythrospila								+				
fugax								+				
gigantea		+	+					+	+		+	
graminea								+				
nobleae								+				
phlei	+							+				
poae								+				
siccans								+				
teres								+				
tetrarrhenae								+				+
triseptata								+				
tritici-repentis			+					+	+			
tuberosa								+				

* Groups are named in Table 21.

Table 23. Host ranges in the Poaceae for species of *Bipolaris*

Fungus	Grass hosts (by groups)											
	1a	1b	2	3	4	5	6	7	8	9	10	11
australiensis	+		+					+	+			
australis			+									
bicolor	+	+						+				
buchloes			+									
chloridis			+									
clavata			+									
coicis	+											
crustacea			+									
cylindrica			+									
cynodontis	+	+	+					+				
dactyloctenii		+	+									
ellisii			+									
eragrostidis			+									
euchlaenae	+											
flagelloidea		+										
hawaiiensis	+	+	+					+	+			
kusanoi			+									
leersiae		+			+				+			
maydis	+	+	+									
mediocre		+										
melinidis		+										
micropus		+	+									
miyakei			+									
neergaardii									+			
nodulosa		+	+									
oryzae	+								+			
ovariicola			+									
panici-miliacei		+										
papendorfii	+	+	+									
peregianensis			+									
perotidis		+	+					+				
ravenelii			+									
sacchari	+	+										
setariae		+										
siliculosa					+							
sorghicola	+											
sorokiniana	+	+	+				+	+				+
spicifera	+	+	+					+	+			
stenospila	+											
tripogonis			+									
urochloae	+	+										+
victoriae	+	+	+					+				
yamadae		+										
zeicola	+	+	+				+	+				+
zizaniae									+			
undet. spp.	+	+	+	+		+	+	+				+

Table 24. Host ranges in the Poaceae for species of *Exserohilum*

Fungus	Grass hosts (by groups)											
	1a	1b	2	3	4	5	6	7	8	9	10	11
gedarefensis	+											
holmii	+		+									
monoceras	+	+										
pedicellatum	+							+	+			
prolatum	+											
rostratum	+	+	+	+			+	+	+			+
turcicum	+	+						+				

morphological and biological differences between anamorph genera reflect profound genetic discontinuities as shown by teleomorph correlations. There is now no impediment to recognising the genera *Drechslera*, *Bipolaris*, and *Exserohilum*. It is hoped that users of the classification in various applied fields will benefit from a stable generic nomenclature.

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APPENDIX: COLLECTION DETAILS FOR CULTURES USED IN TESTS OF GENERIC CHARACTERISTICS

In part 1, which comprises isolates to which a binomial has been applied, the species are listed alphabetically by specific epithet. The genera to which these names have been assigned on the basis of the results reported in this paper can be ascertained by consulting Table 20 in the text. Isolates to which no name has yet been applied are listed in part 2, alphabetically by host genus.

Each entry has the collector's number, host or substrate, locality, date collected (or received by writer), and collector's name. The last item in each entry is the BRIP accession number, in brackets, for the voucher specimen deposited in that herbarium. Localities where there is no state or country indicated are in Queensland, Australia.

Part 1. Data for named isolates

andersenii
   52/78a *Hordeum murinum* L., Wairarapa district, North Island, New Zealand, 1/78, J.E. Sheridan (13063).

australiensis
   7750a *Bromus unioloides* Kunth, Spring Ck., Broadwater, 1/3/77, J.L.A. (12112).

australis
   77126 *Sporobolus caroli* Mez, Yelarbon, 11/5/77, J.L.A. (12513).

avenae
   DAR 33699 *Avena fatua* L., Hay, New South Wales, 13/7/79, B. Semple (13049).
   LEV 11079a *Triticum aestivum* L., New Zealand, 10/76, J.G. Hampton & D. Matthews (12834).

bicolor
19682a *Sorghum bicolor* (L.) Moench, Bundaberg, 18/4/72, K.G. Pegg (11420).
biseptata
21 *Agrostis* sp., Melbourne, Victoria, 2/8/78, M. Mebalds (12977).
brizae
DAOM 75443 *Gastridium ventricosum* (Gouan) Schinz & Thell., Copperopolis, California, U.S.A., 29/8/57, R. Sprague & G.W. Fischer (6505).
CBS 190.29 *Briza minor* L., Japan, Y. Nisikado & C. Miyake (12279).
7855 *B. maxima* L., Epping, New South Wales, 6/12/78, M. & J. Walker (12784).
bromi
DAOM 169239 *Bromus inermis* Leysser, Bathurst, Ontario, Canada, 6/10/78, R.A. Shoemaker (12769).
cactivora
IMI 160989 *Parodia* sp., Great Britain (imported from Belgium), 6/71, W.A. Hughes (8501).
campanulata
PDDCC 6170 *Sieglingia decumbens* (L.) Bernh., Waikumete, New Zealand, 9/11/76, E.H.C. McKenzie 368 (12365).
60/78 *Avena sativa* L., Wairarapa district, North Island, New Zealand, 4/79, J.E. Sheridan (12894).
7914 *Triticum aestivum*, New Zealand, 3/79, J.G. Hampton & D. Matthews (12842).
catenaria
DAOM 139513 *Poa trivialis* L., Agassiz Research Station, British Columbia, Canada, 7/72, J.D. Smith (6518).
116 *Agrostis palustris* Huds., Ohio, U.S.A., 5/77, A. Hagan (12965).
chloridis
7670 *Chloris gayana* Kunth, Traveston Ck., near Gympie, 24/9/76, J.L.A. (11976).
clavata
77144c *Dactyloctenium radulans* (R.Br.) Beauv., Goondiwindi, 12/5/77, J.L.A. (12530).
coicis
CBS 192.29 *Coix lacryma-jobi* L. var. *typica* Makino, Kurashiki, Japan, Y. Nisikado (12280).
7-3-2 *C. lacryma-jobi* var. *susutama* (Sieb.) Makino, Kino, Kyoto-Sakyoku, Japan, 10/75, M. Tsuda (6513).
colocsiae
IMI 172992 *Colocasia esculenta* (L.) Schott, Allahabad, India, M.P. Tandon & V. Bhargava (13357).
crustacea
1458 *Sporobolus elongatus* R.Br., Buchans Point, 18/5/79, G.I. Johnson (12952).
7981 *S. fertilis* (Steudel) W.D. Clayton, Redlynch, Cairns, 3/10/79, J.H. Simmonds (12992).
cylindrica
77152 *Sporobolus creber* De Nardi, Yetman, New South Wales, 12/5/77, J.L.A. (12551).
77154 *S. creber*, Yetman, New South Wales, 12/5/77, J.L.A. (12554).
7824 *S. elongatus*, Warrill View, 11/5/78, M.J. Ryley (12637).
7835 *Sporobolus* sp., Sugarloaf district, near Toowomba, 21/6/78,

cynodontis

DAR 28721a *Cynodon dactylon* (L.) Pers., The Spit, New South Wales, 11/5/77, J. Walker 77/401 (6487).

dactylidis

DAOM 126766 *Lolium* sp., West Germany, 9/9/78, U.G. Schlösser (6504).

dactyloctenii

7808b *Melinis minutiflora* Beauv., Queensland, 7/4/78, J.L.A. (12602).

dematioidea

PDDCC 6215 *Holcus lanatus* L., Kaikohe, New Zealand, 6/9/76, E.H.C. McKenzie 309 (12817).

PDDCC 6216 *Cortaderia* sp., Whangarei, New Zealand, 8/9/76, E.H.C. McKenzie 315 (12813).

dictyoides

7738a *Festuca arundinacea* Schreber, Severnlea, 28/2/77, J.L.A. (12101).

ellisii

DAOM 155097 Isolated from air, Karachi, Pakistan, 1958, M.S. Quraishi (6508).

erythrospila

30 *Agrostis* sp., Frankston, Victoria, 28/11/78, M. Mebalds (12968).

fugax

VPRI 10690 *Agrostis stolonifera* L., Frankston, Victoria, 4/79, M. Mebalds (12918).

655 *A. tenuis* Sibth., Ottawa, Canada, comm. 7/79, A. Hagan (12999).

gedarefensis

8021 *Sorghum bicolor*, Sudan, comm. 9/9/80, A.E. El Shafie (13124).

graminea

DAOM 159452 *Hordeum vulgare* L., Welling, Alberta, Canada, 24/8/76, T.G. Atkinson 77M-1 (6515).

hawaiiensis

7770 *Chloris gayana*, Dalveen, 1/3/77, J.L.A. (12129).

holmii

$7795b_2$ *Dactyloctenium radulans*, Goondiwindi, 25/4/77, Y. Brouwer (12679).

homomorphus

ATCC 13409 Isolated from air, Kansas State College, U.S.A., 11/6/57, C.T. Rogerson B.227-14 (8515).

incurvata

7783 *Chrysalidocarpus lutescens* H. Wendl., Yandina, 30/3/77, R. Peterson (12144).

indica

20114 *Amaranthus hybridus* L., Forest Hill, 30/3/73, P.E. Mayers (11561).

iridis

PDDCC 6129 *Iris* sp., Auckland, New Zealand, 7/77, E.H.C. McKenzie (12353).

DAR 29777 *Lachenalia pallida* Soland., Devonport, Tasmania, 23/8/77, B. Beattie (6489).

khartoumensis

HME 4006 *Sorghum bicolor*, Sudan, comm. 10/81, A.E. ElShafie & J. Webster (13484).

kusanoi

CBS 137.29 *Eragrostis major* Host., Kurashiki, Japan, Y. Nisikado (12278).

leersiae
 7704 *Leersia hexandra* Swartz, Ormiston, 24/1/77, J.L.A. (12072).
maydis
 3824A *Euchlaena mexicana* Schad., Kairi, comm. 28/4/72, W. Pont (5113).
 19629 *Zea mays* L., Kairi, 23/3/72, W. Pont (5069).
 19679 *Echinochloa colona* (L.) Link, Obi Obi, 18/4/72, J.L.A. 72068 (5039).
 20239 *Zea mays*, Gowrie Ck., near Ingham, 12/6/73, W. Pont (5094).
 DAOM 133691 *Z. mays*, Harrow, Ontario, Canada, 8/70, L.F. Gates (12447).
melinidis
 7837 *Melinis minutiflora*, Atherton, 6/78, J.M. Lenné (12690).
micropus
 DAOM 71176 *Leptochloa filiformis* (Lam.) Beauv., Stillwater, Oklahoma, U.S.A., 29/8/60, R.A. Shoemaker (6509).
 8452 *Paspalum notatum*, Lakeland, Florida, U.S.A., 3/4/70, E.S. Luttrell (6516).
monoceras
 7792a *Echinochloa colona*, Biloela, 13/4/77, M. Vincent (12236).
multiformis
 1215 *Tribulus terrestris* L., Bloemfontein, South Africa, comm. 7/77, W.J. Jooste (12275).
neergaardii
 DAOM 154282 *Oryza sativa* L., Ghana, 1973, O.-A. Danquah (12919).
nicotiae
 PC 2230 Isolated from soil, Tassili, Algeria, comm. 9/76, J. Nicot (11983).
nobleae
 112 *Lolium multiflorum* Lam., Otara, New Zealand, 10/7/75, E.H.C. McKenzie (12815).
 5063 *L. multiflorum* x *perenne* L., New Zealand, 1975, E.H.C. McKenzie (12356).
 5832 *L. multiflorum* x *perenne* L., New Zealand, 1975, E.H.C. McKenzie (12812).
 15063 *L. multiflorum*, New Zealand, 1975, E.H.C. McKenzie (12334).
nodulosa
 20365 Unidentified grass, Coolabunia, 13/12/72, J.L.A. (11476).
oryzae
 12/76 *Oryza sativa*, Hyogo-Ken, Japan, 12/76, M. Tsuda (12285).
ovariicola
 7825 *Eragrostis interrupta* Beauv., Tully River Heads, 12/5/78, R.F.N. Langdon (12678).
papendorfii
 77151 *Eragrostis pilosa* (L.) Beauv., Yetman, New South Wales, 12/5/77, J.L.A. (12538).
pedicellatum
 4951 *Oryza sativa*, Clare, 11/10/76, M. Finlay (12040).
 113 *Triticum aestivum*, Oakey, 24/1/77, R.L. Dodman (12226).
 8046 *Sorghum bicolor*, Mywybilla, 20/10/77, P.E. Mayers (12406).
peregianensis
 7842b *Cynodon dactylon*, Peregian Beach, 27/8/78, J.L.A. (12727).
perotidis
 7821a *Perotis rara* R.Br., Mundubbera, 15/5/78, J.L.A. (12665).

phlei
   DAOM 124884 *Phleum pratense* L., Lacombe, Alberta, Canada, 6/68, W. Berkenkamp (6506).
poae
   DAOM 169240 *Poa pratensis* Nees, Central Experimental Farm, Ottawa, Canada, 6/10/78, M. Barkworth & R.A. Shoemaker (12768).
   KB 6 *P. pratensis*, Beltsville, Maryland, U.S.A., 4/79, A. Hagan (12969).
prolatum
   Ep. 1 *Zea mays*, Guatemala, 2/72, K.J. Leonard (12221).
ravenelii
   8335 *Sporobolus poiretii* (Roem. & Schult.) Hitchc., Midville, Georgia, U.S.A., 18/7/69, E.S. Luttrell (12899).
   77109 *S. africanus* (Poir.) Robyns & Tournay, Lamington National Park, 9/5/77, J.L.A. (12262).
   DAR 28765 *S. africanus*, Red Cedar Flat, Royal National Park, New South Wales, 8/6/77, J. Walker 77/413 (6491).
rostratum
   77162a *Eragrostis pilosa*, Samford, 25/5/77, J.L.A. (12270).
sacchari
   20721 *Saccharum officinarum* L., Eight Mile Plains, 12/7/74, D. Steindl (11646).
setariae
   8562 *Setaria italica* (L.) Beauv., Bloomington, Indiana, U.S.A., 1/9/70, E.S. Luttrell (6512).
siccans
   5066 *Lolium multiflorum* x *perenne*, New Zealand, 1975, E.H.C. McKenzie (12338).
sorghicola
   7791 *Sorghum bicolor*, Biloela, 7/4/77, P.E. Mayers (12154).
sorokiniana
   7723 *Bromus unioloides*, Accommodation Ck., Ballandean, 28/2/77, J.L.A. (12085).
spicifera
   77144b *Dactyloctenium radulans*, Goondiwindi, 12/5/77, J.L.A. (12529).
stenospila
   DAOM 147411 *Saccharum officinarum*, Cuba, 1952, E.S. Luttrell 825 (6503).
subpapendorfii
   PC 2227 Isolated from soil, Kharga, Egypt, comm. 9/76, J. Mouchacca (11984).
teres
   1535 *Hordeum vulgare*, Allora, 9/6/77, R.G. Rees (12327).
   DAR 33700 *H. leporinum* Link, Hay, New South Wales, 9/7/79, B. Semple (13048).
tetrarrhenae
   7725a *Microlaena stipoides* (Labill.) R.Br., Eukey, 28/2/77, J.L.A. (12087).
   7765b *M. stipoides*, Amiens, 1/3/77, J.L.A. (12126).
tripogonis
   77158 *Tripogon loliiformis* (F. Muell.) C.E. Hubbard, Yetman, New South Wales, 12/5/77, J.L.A. (12265).
   77166 In culture, single ascospore isolates, 11/8/77, J.L.A. (12273).

triseptata
14769 *Lolium perenne*, New Zealand, 1975, E.H.C. McKenzie (12354).
7754 *Holcus lanatus*, Storm King Dam, Stanthorpe, 28/2/77, J.L.A. (12117).
PDDCC 6120 *H. lanatus*, Oratea, New Zealand, 17/2/75, E.H.C. McKenzie (12816).
tritici-repentis
21615 *Triticum aestivum*, Valantine Plains, Biloela, 8/76, R.G. Rees (12622).
1511 *Agropyron scabrum* (Labill.) Beauv., Formartin, 9/11/76, R.G. Rees (12623).
7818 *Triticum aestivum*, Toowoomba, 19/4/78, R.G. Rees (12616).
7819 *T. aestivum*, Kingsthorpe, 19/4/78, R.G. Rees (12617).
tuberosa
51/78 *Hordeum murinum*, Wairarapa district, North Island, New Zealand, 1/78, J.E. Sheridan (12914).
DAOM 134961 *H. vulgare*, Bonn, Germany, 8/9/71.
turcicum
77159 *Sorghum bicolor*, Samford, 25/5/77, J.L.A. (12267).
7333 *Zea mays*, Toowoomba, 25/8/76, P.E. Mayers (11926).
PDDCC 6121 *Z. mays*, Pukekohe, New Zealand, 4/77, R.A. Fullerton (12343).
urochloae
20421 *Z. mays*, Kingaroy, 18/1/73, P.E. Mayers (11510).
77127 *Urochloa panicoides* Beauv., Yelarbon, 11/5/77, J.L.A. (12514).
victoriae
IMI 89977 *Avena sativa* L., U.S.A., F. Meehan, comm. C.M.I. 1961, authentic for the name (12648).
yamadae
CBS 202.29 *Panicum miliaceum* L., Kurashiki, Japan, Y. Nisikado (12283).
zeicola
77107a *Microlaena stipoides*, Lamington National Park, 9/5/77, J.L.A. (12257).

Part 2. Data for unidentified isolates

7643b *Axonopus affinis* Chase, Peregian Beach, 6/6/76, J.L.A. (11740).
5140 *Brachiaria decumbens* Stapf, South Johnstone, 9/6/77, W. Pont (12289).
21067 *Crinum zeylanicum* L., St. Lucia, 3/4/75, R.C. Colbran (11750).
7797a *Diplachne fusca* (L.) Beauv., Goondiwindi, 25/4/77, Y. Brouwer (12245).
77100 *Entolasia stricta* (R.Br.) Hughes, White Caves, Lamington National Park, 9/5/77, J.L.A. (12249).
77161 *Eragrostis pilosa* (L.) Beauv., Samford, 25/5/77, J.L.A. (12269).
77187a *Eragrostis* sp., Cunningham's Gap, 2/12/77, J.L.A. (12470).
5421 *Heteropogon contortus* (L.) Beauv. ex Roemer & Schultes, Southedge, 18/1/78, W. Pont (12558).
7774a *Microlaena stipoides* (Labill.) R.Br., Cunningham's Gap, 1/3/77, J.L.A. (12134).
77107c *M. stipoides*, Lamington National Park, 9/5/77, J.L.A. (12259).
5422 *Panicum maximum* Jacq. var. *trichoglume* Eyles ex Robyns, Southedge, 18/1/78, W. Pont (12560).

77108a *P. pygmaeum* R.Br., Lamington National Park, 9/5/77, J.L.A. (12260).
77177a *P. pygmaeum*, Lamington National Park, 29/11/77, J.L.A. (12466).
7810b *Paspalidium distans* (Trin.) Hughes, Peregian Beach, 9/4/78, J.L.A. (12610).
77131 *P. jubiflorum* (Trin.) Hughes, Goondiwindi, 11/5/77, J.L.A. (12519).
20355 *Pennisetum clandestinum* Hochst. ex Chiov., Yarraman, 13/12/72, J.L.A. 72166 (11481).
7821b *Perotis rara* R.Br., Mundubbera, 15/5/78, J.L.A. (12660).
19822 *Rhynchelytrum repens* (Willd.) C.E. Hubbard, Southedge, 3/72, K.H. Halfpapp 20 (10991).
SI.3686 *Sporobolus* sp., Guadalcanal, Solomon Islands, 3/5/78, E.H.C. McKenzie (12720).
3 *Triticum aestivum* L., Toowoomba, comm. 30/7/76, R.G. Rees (11767).
7779a *Urochloa panicoides* Beauv., Biloela, 17/3/77, D. Persley (12142).
20387 *Zea mays* L., Christmas Ck., 8/1/73, J.L.A. (11501).
7681c *Zoysia macrantha* Desvaux, Peregian Beach, 14/11/76, J.L.A. (12030).

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AN ANNOTATED INDEX FOR E.M. FRIES'S OBSERVATIONES MYCOLOGICAE.

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Summary

An index to names adopted in Fries's Observationes Mycologicae is furnished, with a discussion and notes on the effect of changes in Article 13 of the ICBN.

In some previous publications (Petersen, 1976, 1977a, b), while ostensibly providing indices to pre-1821 compendia of fungi, I have drawn attention to other information gleaned during the routine search for the origins of names used by influential pre-Fries authors, including Bulliard, Schaeffer and Bolton. While the change in Article 13 of the ICBN wrought in 1982 (cfr. Korf, 1982a, b) eliminated the imposition of an arbitrary date in the validation process of fungus names, it left names adopted in Fries's Systema Mycologicum and Elenchus Fungorum (and Persoon's Synopsis) with "protected" status, much as they had had before the change. These "sanctioned" names are to be used over all earlier synonyms and homonyms.

Equally important, however, are those names not sanctioned by Persoon or Fries in their appropriate fungal groups. These names, according to new Arts. 13, start their nomenclature with Linnaeus, 1 May 1753. Like all other names, they may be divided into two groups: a) those names which find no competitors (synonyms or homonyms) for priorability; and b) those names which for some reason (validity, legitimacy) find competition for priorability.

Inherent in the new Art. 13 is the problem of establishing "clear title" for unsanctioned names. The taxonomist must assume that no unsanctioned name has "clear title" until so proven. The process of proving "clear title" involves a search through the post-Linnaean, pre-Systema literature for earlier synonyms, homonyms and recombinations which would block this "clear title" of priorability. This search appears relatively simple if only the sources in Persoon's and Fries's protologues were involved. In reality, the number of publications to be searched is very significant (surely in the hundreds), and their obscurity hardly recognized. The idiosyncracies of this subject will be dealt with in a separate paper.

In an attempt to use the new Art. 13 in a systematic fashion, I have selected a pre-sanction pair of publications, E.M. Fries's *Observationes Mycologicae* (Fries, 1815, 1818) for analysis. Ostensibly, as before, the rationale has been to provide an index of names adopted in these publications (henceforth abbreviated FOM1 and FOM2). How better to assess a large number of such names and to ascertain their origins and their fates under the new Art. 13 than to use Fries's own contributions? As a result of this analysis, the following points may be offered.

1. In FOM1 and FOM2 Fries adopted a total of 896 names at infrageneric, specific and infraspecific ranks.

2. Of this number, 390 (43.6%) represented either new taxa (in Fries's estimation) or binomials for organisms previously represented only by polynomials.

3. Of the total number of names (896), Fries subsequently sanctioned (in *Systema* and *Elenchus*) 498 (55.6%). Conversely, Fries did *not* sanction 398 (44.4%).

4. Of the 398 names from FOM1 and FOM2 *not* subsequently sanctioned by Fries, 306 were names originated by Fries himself (92 were names originated by other authors).

5. In FOM1 and FOM2 Fries originated 80 names for organisms which by his own literature citations, already had previous names. Such Fries names would be *nomina superflua* under the ICBN (which, of course, did not exist at that time).

6. Of the *nomina superflua*, Fries subsequently sanctioned 53 (66.3%). Interestingly, he did *not* sanction 27 (33.7%), but in all those cases, he reverted to the older name, sanctioning (either directly or indirectly) the names he had superceded in FOM1 and FOM2. By implication, these Friesian names must be considered as the *nomina superflua* they are, making them illegitimate and impriorable.

7. The enormous influence of Persoon (1801) on Fries is evident when, under *Agaricus*, the taxa are taken up in exactly the order presented by Persoon.

8. In selecting names for FOM1 and FOM2, Fries opted for the name with the best supporting material (illustrations, circumscription, etc.) -- the one to which he could most completely and comfortably match the fungi which he knew -- rather than the oldest or the one with "clearest title". When these names were adopted in the *Systema* (≡ sanctioned), their fates became clear (in retrospect), but when they were not, their use merely served to make the later nomenclatural waters murkier.

The statistics presented above can be compared with similar figures gleaned from indexing Bulliard's *Histoire* (Petersen, 1977a) and Bolton's *History* (Petersen, 1977b). The statistics are revealing both of the selection process of Fries (for *Systema*) and the authors themselves.

1. Bulliard adopted a total of 642 names in *Histoire*, Bolton 215.

2. Of these, Bulliard coined 543 (84.6%) *new* names (either new to science or replacements for polynomials), while Bolton proposed 27 (12.6%).

3. Of these new names, Fries sanctioned 188 (34.6%) of Bulliard's names, but none of Bolton's.

4. Bulliard proposed 213 (33.2% of the total names) *nomina superflua*. Some doubt exists as to Bolton's care in citations, but his *nomina superflua* are either 85 or 126 (39.5 or 58.6%).

5. Of these *nomina superflua*, Fries sanctioned 56 (26.3%) of Bulliard's, and only 9 (10.6 or 7.1%) of Bolton's.

The Index

The information contained in the index can be summarized as follows:

Column 1. The list is of names arranged alphabetically under generic names also listed alphabetically.

Column 2. The part (1 or 2) and page on which the name in column 1 is to be found in FOM.

Column 3. The nomenclatural history of the names in column 1. "Sp. nov." or "var. nov.": new taxa proposed by Fries. "Nom.

nov.": a name supplied by Fries for a taxon previously represented only by a polynomial. "Nom. superfl.": a name supplied by Fries to represent a taxon which, according to Fries's own bibliographic citations, was already represented by a binomial.

Column 4. The volume and page in *Systema Mycologicum* ("EL" = *Elenchus*) where sanction of the name in column I can be found. When this column is blank, the name was not adopted (≡ sanctioned) in *Systema*.

Column 5. Reference to additional explanatory notes located behind the index. Notes are by cumulative number even though divided by genus.

In the notes, judgements are made on the priorability of names in situations of *nomina superflua*. Because all Fries's names in *Systema* are protected, the fate of their earlier nomenclatural synonyms (typonyms) is automatically sealed, unless in *Systema* Fries treats these names differently than in FOM.

While Fries's use of the rank of Tribus is noted in the ICBN (Art. 33.5), that exception applies only to use in the *Systema*. Fries's use of Tribus in FOM is *not* excepted from normal usage, so all tribe names violate Art. 4.

Acronyms in the cited literature in the index refer to literature listed in previous publications (Petersen, 1975-1976). Because this is cumbersome for the reader, the following quick reference list is provided.

A & S = Albertini & Schweinitz. 1805.
AbS = Abbildung der Schwämme. 1790-1793.
BEF, BEFC = Batch, Elenchus et continuo. 1783-1789.
BH = Bulliard, Histoire. 1809-1812.
Bolt = Bolton, History. 1788-1789.
CFL = Curtis, Flora Londinensis.
DC Synop = DeCandolle, Synopsis.
FD = Flora Danica.
FNS = Fries, Novitiae. 1814-1819.
HDF = Hoffmann, Deutchlands Flora. 1795.
Hoffm = Hoffmann, Nomenclator. 1789-1790.
JColl = Jacquin, Collect.
LFS = Linnaeus, Flora Suecica.
LSP = Linnaeus, Species Plantarum. 1753.
PAB = Persoon, Neue Ann. Bot., Usteri S. 1794.
PC = Commentatio. 1797.
PCS = Persoon, Commentarius . . . Schaefferi. 1800.
PIC, PID = Persoon, Icones et descriptiones. 1798-1800.

PIP = Persoon, Icones Pictae.
POM = Persoon, Observationes. 1796-1799.
PS = Persoon, Synopsis. 1801.
Roth Cat = Roth. Catalogus.
Sae = Schumacher. Enumeratio. 1801-1803.
Sch = Schaeffer. Fungorum. 1762-1774.
Schr = Schrader, Spicilegium. 1794.
Scop = Scopoli. Flora Carniolica. 1772.
SEF = Sowerby. English fungi. 1797-1805.
Sib = Sibthorp. Flora Oxoniensis. 1794.
SwVAH = Swartz. Vekens. Acad. Handl.
TFM, Tode = Tode. Fungi Mecklenburgensis. 1790-1791.
TRAT = Trattinnick. Fungi Austriaci. 1805-1806.
WFL = Wahlenberg. Flora Lapponica. 1812.
WJ = Wulfen. in Jacquin's Miscellanea. 1778-1781.

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Name	Reference in Observationes	Protologue	Reference in Systema	Note
		ACROSPERMUM		
caliciiforme	2: 311	sp. nov.	----	
fluxile	2: 312	sp. nov.	----	
micans	2: 311	HDF 2: 27 (Clavaria)	1: 497	1
		ACTIDIUM		
acharii	1: 190	sp. nov.	2: 596	
hysterioides	2: 353	nom. superfl.	2: 596	2
		AGARICUS		
acris	1: 62	PS: 437 ← Bolt: 2: 60	1: 65	
acutus	2: 37	PS: 316	1: 233	
adiposus	2: 18	sp. nov.	----	3
adonis	2: 160	PS: 391 ← BH: 445, pl. 560	1: 152	
adustus	1: 78	PS: 459	1: 60	
africatus	2: 213	nom. nov.	1: 169	4
agaricola, parasiticus var.	2: 150	nom. & var. nov.	----	5
agathosmos	1: 16	sp. nov.	----	
aglidius, nitratus var.	2: 101	var. nov.	----	
albicans l. flavescens, ericetorum var.	1: 87	A&S: 225	----	6

albobrunneus	1: 7	PS: 293	----	7
albo-brunneus	2: 118	PS: 293 (Cortinarius)	1: 37	8
albo-violaceus	2: 84	PS: 286	1: 218	9
albus	1: 9	PS: 363	----	
alcalinus	2: 153	sp. nov.	1: 142	
aleuriatus	1: 49	nom. superfl.	1: 238	10
alliaceus	1: 30	Jacq. Obs. Bot., 100	1: 140	
alutaceus	1: 71	PS: 441 ← Scop 2: 436 (Russula)	1: 55	
ambiguus, cretaceus var.	1: 13	var. nov.	----	
ammoniacus, alcalinus var.	2: 155	var. nov.	----	
anomalus	2: 73	sp. nov.	1: 220	11
anserinus, personatus var.	2: 91	var. nov.	----	
apalus	2: 142	sp. nov.	1: 265	
approximatus, peronatus var.	1: 24	var. nov.	----	
apricarius, peronatus var.	1: 24	var. nov.	----	
aquatilis, peucopus var.	2: 40	var. nov.	----	
aquilus, esculentus var.	2: 135	var. nov.	----	12
argematus	2: 190	sp. nov.	1: 75	
argentatus	1: 7	PS: 286	1: 218	
argynopus, castaneus var.	2: 44	var. nov.	----	
argillaceus	2: 47	POM 1: 51	----	
armillatus	2: 61	sp. nov.	1: 214	13
asemus, butyraceus var.	2: 124	var. nov.	----	14
aspideus	2: 189	sp. nov.	----	
atro-coeruleus	1: 95	sp. nov.	1: 190	15
aurivellus	2: 17	A&S: 148 ← BEFC 1: 153	1: 242	
balteatus	2: 138	sp. nov.	----	
batschii	1: 47	nom. superfl.	----	16
bicolor, personatus var.	2: 90	stat. nov.	----	17
bivelus	2: 58	sp. nov.	1: 215	

blennius	1: 60	nom. nov.	1: 67	
bolaris	2: 52	PS: 291	1: 228	
boltonii	2: 186	PS: 114	1: 303	
brumalis	2: 206	sp. nov.	1: 171	
brunneus	2: 57	PS: 274	1: 211	
bulbosus	2: 60	SEF: p.f.p. 130 ← PS: 195	1: 214	
butyraceus	2: 123	BH: 615, pl. 572	1: 121	
caesius, castaneus var.	2: 43	FD: pl. 1010	----	
callisteus	2: 51	sp. nov.	1: 228	
callochrous	2: 68	PS: 282	1: 224	18
callosus	2: 180	sp. nov.	1: 292	19
calopus	2: 151	PS: 373	1: 130	
camarophyllus	2: 107	A&S: 177	1: 99	
campanella	1: 88	PS: 469 ← BEF: 74	1: 166	
campanulatus	2: 173	PS: 426 ← BH: 431	----	
candicans	1: 77	PS: 456	1: 91	
candidus	1: 8	BEFC 1: 133	1: 249	
candollianus	2: 182	nom. superfl.	1: 296	20
caperatus	1: 5	POM 1: 48	1: 241	
capnoides	2: 27	sp. nov.	1: 289	
carbonarius	2: 33	sp. nov.	1: 252	
carpophilus	1: 45	sp. nov.	----	
castaneus	2: 42	A&S: 161 ← PS: 298	1: 235	
caudatus	2: 187	sp. nov.	----	
cepaceus	1: 29	sp. nov.	1: 129	
cernuus	1: 50	FD 17: 9, pl. 1008	1: 298	21
cestatus	2: 219	sp. nov.	----	
cetratus	2: 218	sp. nov.	----	
chalazinus, pratensis var.	2: 117	stat. & nom. nov.	----	22
chalybeus	2: 95	PS: 343 ← PIP, pl. 4	1: 203	

chioneus	1: 66	nom. superfl.	----	23
chloranthus	2: 156	sp. nov.	1: 152	
chrysoleucus	1: 77	PS: 457	1: 167	
cinereus, pratensis var.	2: 117	PS: 305	----	
cinnamomeus	2: 35	PS: 297 ← Bolt. pl. 150	----	24
cirrhatus, tuberosus var.	1: 39	PS: 374 ← POM 2: 52	----	
citrinellus	1: 44	PS: 384 ← PID: 44	1: 155	
clandestinus	2: 166	sp. nov.	1: 206	
claricolor, multiformis var.	2: 65	var. nov.	----	
cochleatus	1: 74	PS: 450 ← Abb. Schw. 3: pl. 26	1: 177	
collariatus	2: 164	sp. nov.	----	
collinus	2: 133	Scop 2: 432	1: 124	
communis, butyraceus var.	2: 123	stat. & nom. nov.	----	25
conchatus	2: 224	BH: index, pl. 398 ← Schr: 132	1: 181	
concolor, pictus var.	2: 220	var. nov.	----	
confluens	1: 11	PIC: 15 ← POM 1: 8	1: 123	
conformis, butyraceus var.	2: 125	var. nov.	----	
conigenus	1: 36	PS: 388 ← Buxb. Cent. 1: 36	1: 132	
consobrinus	2: 195	sp. nov.	1: 60	
Coprinoidei (Tribus)	2: 175		1: 300	26
coprinus	2: 175	sp. nov.	1: 279	
coriarius, montanus var.	1: 53	var. nov.	----	
corticatus	1: 22	sp. nov.	1: 179	
corticatus	1: 92	sp. nov.	----	27
cretaceus	1: 13	PS: 369	1: 95	
crocatus	1: 32	PS: 380 ← Schr: 127	1: 148	
croceo-caeruleus	2: 85	stat. nov.	1: 238	28
cucullatus	2: 147	PS: 372	1: 158	
cucumis	2: 40	POM 1: 45	1: 231	
cuneifolius	2: 99	sp. nov.	1: 116	

cyathoides	2: 205	PS: 460 ← Bolt 4: 145	----	
dasypus, decastes var.	2: 107	stat. nov.	----	29
decastes	2: 105	sp. nov.	1: 49	
decipiens	2: 42	PS: 299	1: 236	
decumbens	2: 49	A&S: 157 ← PS: 286	----	
depexus	2: 53	nom. superfl.	1: 230	30
dendrophilus, fibrillosus var.	2: 181	var. nov.	----	
depallens, linnaei var.	1: 69	stat. nov.	----	31
Desmopus (Tribus)	2: 26		----	
diatretus	2: 200	sp. nov.	1: 83	
dicolor	1: 80	PS: 462	----	
dicroninus, leucopus var.	2: 40	var. nov.	----	
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dilatatus	1: 40	sp. nov.	----	
discoxanthus	1: 15	sp. nov.	----	
dissimilem, pyrogalus var.	1: 64	var. nov.	----	
ditopus	1: 91	sp. nov.	1: 171	
dubius, esculentus var.	2: 135	stat. & nom. nov.	----	32
elegans	2: 167	A&S: 391 ← PS: 391	1: 149	
elegantior, multiformis var.	2: 64	var. nov.	----	
elongatum, pyrogalus var.	1: 64	var. nov.	----	
elongatus	1: 44	PS: 384 ← PIC: 3	----	33
emeticus, linnaei var.	1: 67	Sch 4: 9, pl. 15	----	34
ephebeus	2: 87	nom. superfl.	1: 238	35
epiphegus, ulmarius var.	1: 93	var. nov.	----	
epichysium	1: 82	PS: 462 ← PIC: t. 13	1: 169	
ericaeus	2: 177	PS: 413	1: 291	
ericetorum	1: 87	"A&S: 225"	----	36
ericosus, pratensis var.	2: 117		----	37
erythrinus, castaneus var.	2: 44	var. nov.	----	

erythropus	1: 10	PS: 367, as var.	1: 122	
escharioides	2: 131	sp. nov.	1: 260	
esculentus	2: 134	TRAT: 65 ← WJ 2: 103	1: 131	
eumeces, tenacellus var.	2: 136	var. nov.	----	
evernius	2: 79	nom. superfl.	1: 212	38
exilis	2: 95	sp. nov.	1: 206	
expallens	1:80	PS: 461	1: 172	
expallens, linnaei var.	1: 69	var. nov.	----	39
fallax	1: 70	sp. nov.	----	
fastibilis	2: 54	A&S: 171 ← PS: 326	1: 249	
ferruginascens, multiformis var.	2: 65	stat. nov.	----	40
fibrillosus	2: 180	PS: 424	1: 297	
ficoides, pratensis var.	2: 116	var. nov.	----	
filigineus	2: 168	sp. nov.	----	
fimbriatus	2: 204	Bolt: 61	1: 94	
flabelliformis	1: 96	PS: 479	1: 185	
flavidus	2: 29	A&S: 160 ← Sch 4: 17	1: 250	
flavo-brunneus	2: 119	nom. superfl.	----	41
flavovirens	1: 25	PS: 319 ← Abb. Schw. 3: t. 24	1: 41	42
flexipes	2: 78	PS: 275	1: 212	
flexuosus	1: 58	nom. superfl.	1: 74	43
foetens	1: 73	PS: 442 ← POM 1: 102 (Russula)	1: 59	
fragilis, linnaei var.	1: 68	stat. nov.	----	44
fragrans	1: 76	sp. nov.	----	45
fulgens	1: 8	PS: 294	----	46
fuligineo-lividus, conigenus var.	1: 36	var. nov.	----	47
fuligeneus	1: 53	PS: 427	----	
fumosus	2: 102	A&S: 175 ← PS: 348	1: 88	
furfuraceus	2: 24	PS: 454	1: 262	
furvus	2: 125	sp. nov.	----	

galochrous	1: 65	nom. superfl.	----	48
galopus	1: 34	PS: 379 ← POM 2: 56	1: 143	
Galorrheus (Tribus)	2: 188		1: 61	
glycyosmus	2: 194	sp. nov.	1: 72	
geophilus	2: 86	A&S: 173 ← PS: 340	----	49
Graveolentes (Tribus)	2: 152		----	
grisea, consobrinus var.	2: 196	var. nov.	----	
grisella, ericetorum var.	1: 87	A&S: 225	----	
griseo-cyaneus	2: 96	sp. nov.	1: 202	50
griseus	1: 47	BEFC 1: 87	----	
Gymnopus (Tribus)	2: 89		----	
haematopus	1: 33	PS: 379 ← POM 2: 56	1: 149	
haustellaris	2: 232	nom. superfl.	1: 274	51
hemisphaericus, cucumis var.	2: 41	var. nov.	----	
hepaticus	1: 86	BEFC 2: t. 38	----	
heteroclitus	2: 223	sp. nov.	----	
heterostichus, furfuraceus var.	2: 25	var. nov.	----	
hinopicus	2: 197	sp. nov.	----	
hirneolus	2: 211	nom. superfl.	1: 206	52
hirtipes	2: 171	SEA 2: 272	1: 206	
hispidulus	2: 97	nom. superfl.	1: 201	53
hornemanni	2: 13	sp. nov.	1: 285	54
humilis	2: 111	A&S: 180 ← PS: 360	----	
hybridus	2: 31	Sw. VAH 1808: 90 ← SEF: p.f.p. 221	----	55
hydrinus, fibula var.	1: 89		----	
hypothejus	2: 10	nom. superfl.	1: 35	56
hysginus	2: 192	sp. nov.	1: 67	
icmadophilus, epichysium var.	1: 82	PS: 463	----	
illinitus	2: 8	nom. superfl.	1: 23	57
imbricatus	1: 27	sp. nov.	1: 42	

inamoenus	1: 10	sp. nov.	1: 111	
incomtus	2: 212	sp. nov.	1: 171	
inopus	2: 32	nom. superfl.	1: 251	58
inquilinus	2: 170	sp. nov.	1: 264	59
integrellus	1: 41	PS: 393 ← PIC: 54	1: 161	
intermedius	1: 57	nom. superfl.	----	60
irregularis, castaneus var.	2: 43	stat. nov.	----	61
laccatus, fastibilis var.	2: 56	stat. & nom. nov.	----	62
laetus	2: 140	PS: 334 ← POM 2: 48	1: 102	
laevigatus	1: 35	PS: 380	----	63
lachnopus	1: 18	sp. nov.	----	
lacmus, pratensis var.	2: 117	stat. nov.	----	64
lacteus	1: 38	PS: 394	1: 152	
lampropus	1: 19	nom. superfl.	1: 203	65
lanuginosus	1: 20	BH: 657	1: 257	
lentus	2: 30	PS: 287	1: 253	
lepideus	1: 21	nom. superfl.	1: 176	66
leptocephalus	1: 31	PS: 381 ← PIC: 12	----	
Leptopus (Tribus)	2: 32		----	
leucinatus, fastibilis var.	2: 56	var. nov.	----	
leucopus	2: 39	PS: 333	1: 236	67
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1. In *Systema* as *Pistillaria.*

ACTIDIUM

2. New name for *Hysterium globosum* PS: 98, which is priorable.

AGARICUS

3. Not BEFC I: 147. Split from *A. squarrosus*.
4. New name for *A. tigrinus* A&S: 220. In Systema I: 169. Fries distances from this synonymy, making A&S: 220 priorable.
5. New name and rank for *A. parasiticus* SAE 2: 308, which is priorable.
6. Polynomial.
7. Also cited is Sch. 4: 18, pl. 38 (*A. striatus*). See also next note.
8. Although varying only in spelling, these two names are not taken up equally in *Systema.*
9. In *Systema* as "*alboviolaceus*".
10. New name for *A. farinosa* Gmel. 2: 1414, and *A. farinulentus* Sch. 4: 45, pl. 205. In *Systema,* Fries excludes synonyms listed in FOM. The former is priorable, the latter devalidated in *Systema* I: 298 as synonym of *A. cernuus* FD: t. 1008: Fr.
11. In *Systema* as *A. anomalus* α *proteus*.
12. In *Systema* I: 208 as *A. aquilus*.

13. In *Systema* cited without protologue (as *nom. nov.*).

14. In *Systema* I: 121 as *A. asemus*.

15. In *Systema* as *A. atrocoeruleus*.

16. New name for *A. atrocyaneus* BEFC I: 101, sanctioned in *Systema* I: 147 with Fries's (1815) name a nomenclatural synonym.

17. PS: 211 as *A. bicolor*.

18. In *Systema*, protologue cited as SpM: 16.

19. In *Systema*, cited without protologue, including FOM.

20. New name for *A. mutabilis* FD, pl. 774, and *A. violaceolamellatus* DC Syn: 31, these names devalidated under ICBN.

21. In *Systema*, attributed to Vahl.

22. New name and rank for *A. clavaeformis* Sch 4: 72, pl. 307. Schaeffer's name was not taken up in *Systema* at species rank (cf. Fr I: 99).

23. New name for *A. niveus* PS: 438. This name in *Systema* I: 58 at varietal rank only.

24. In *Systema*, Fries cites protologue to Linneus Suec. 1205 (LSP: 1173). Therefore, the epithet of Bolton, Persoon, etc. is a devalidated homonym, not synonym.

25. New name and rank for *A. leucophyllus* PS: 309, taken up in *Systema* I: 121, as a synonym of *A. butyraceus* DC: Fr.

26. In *Systema* as Tribus xxxvi, *Coprinarius*.

27. In *Systema*, protologue excludes this citation, but includes preceding.

28. PS: 341 PID: 2 as variety; in *Systema* as "*croceocaeruleus*".

29. PS: 348 as species; in *Systema* I: 50 as *A. dasypus*.

30. New name for *A. subsquamulosus* BEFC 2: 19. In *Systema* I: 230, Batsch's name cited as variety of *A. depexus* only.

31. In *Systema* I: 58t and PS: 440 as *A. depallens*; in FOM I: 69 incorrectly attributed to Schaeffer.

32. New name and rank for *A. esculentus* PS: 389, cited in *Systema* I: 55 at variety rank only.

33. In *Systema* I: 292 as *A. udus* var. *elongatus*, making Persoon's name priorable at species rank.

34. In *Systema* I: 56 as *A. emeticus*, sanctioning Schaeffer's name.

35. New name for *A. villosus* BH: 572, pl. 214, devalidated under ICBN.

36. In *Systema* I: 165, protologue excludes A&S: 225 attribution, citing only FOM I: 87. POM I: 50 cited in protologue to var. *grisellus* only.

37. Introduced with doubtful rank and no protologue.

38. New name for *A. impuber* SEF: p.f.p. 125, devalidated under ICBN.

39. Not PS: 461.

40. *A. ferruginascens* BEFC 2: 32. Cf. *Systema* I: 226. Batsch's name priorable.

41. New name for *A. incertus* Sch 4: 28, taken up in *Systema* I: 37 along with *A. flavo-brunneus* as synonyms of a variety of *A. fulvus* DC: Fr. Neither name is sanctioned in *Systema*.

42. In *Systema* as *A. flavo-virens*.

43. New name for *A. azonatus* BH: 497, taken up in *Systema* at variety rank only.

44. New rank for *A. fragilis* PS: 440. In *Systema* I: 57, sanctioned as species.

45. In FOM I: 76 no protologue is cited, leading to conclusion of new species. In *Systema* I: 171, protologue attributes name to SEF: 10, which is binding under ICBN. FOM I: 76 is devalidated homonym.

46. In *Systema* I: 216, as *A. bivelus* var. *fulgens*. FOM I: 8 incorrectly cites Sch. t. 24 as authority.

47. Synonym cited as *A. conigenus* PS: 388.

48. New name for *A. pectinatus* BH: 599, which is priorable. Fries's name is a later nomenclatural synonym.

49. In *Systema* I: 258, *A. geophyllus* is without protologue at species rank, with FOM 2: 86 cited under one variety, together with PS, A&S and SEF: p.f.p. 124. Under ICBN, the specific epithet starts with *Systema* as though new, for all previous homonyms are relegated to varietal rank. Fries also changed spelling between 1818 and 1821.

50. As "*grideo-cyaneus*". In *Systema*, as *griseocyaneus*.

51. New name for *A. furstedtiensis* BEFC I: 171, devalidated under ICBN.

52. New name for *A. ericetorum* SAE 2: 329, devalidated under ICBN. *Systema* I: 165, same name, with POM I: 50 as authority.

53. New name for *A. hispidus* BEF: 81, devalidated under ICBN.

54. In *Systema*, no protologue is cited.

55. In *Systema* I: 239, as *A. sapineus* var. *hybridus* BH: index.

56. New name for *A. pyxidatus* SAE 2: 321, devalidated under ICBN. Not *A. pyxidatus* in *Systema* I: 164.

57. New name for *A. subcavus* SAE 2: 262, sanctioned in *Systema* I: 28 as separate from *A. illinitus*.

58. New name for *A. radicato-ramosus* Bolt.: 148, devalidated under ICBN.

59. In *Systema*, as *inquilans*.

60. New name for *A. crinitus* Sch 4: 55, devalidated under ICBN, and *A. scrobiculatus* Scop: 450, sanctioned in *Systema* I: 62 over *A. intermedius*.

61. Bolt.: 13, as *A. irregularis*.

62. New rank and name for *A. subtestaceus* BEFC 2: 35, which is priorable.

63. In *Systema* I: 144, as *A. metatus* var. *laevigatus*.

64. New rank for *A. lacmus* SAE 2: 333.

65. New name for *A. columbarius* BH: 575. In *Systema* I: 203, Fries does not cite Bulliard's name, but in *Systema* I: 204 sanctions *A. serrulatus* var. *columbarius* based on this epithet.

66. New name for *A. squamosus* Sch 4: 15, devalidated under ICBN.

67. FOM 2: 39 gives authority as BH: 556, where appears "*leucopodius*". This epithet was treated as a variety of *A. leucopus* by PS: 333.

68. New name for *A. kermesinus* Holmsk. t. 40, devalidated under ICBN.

69. New name for *A. integer* LFS: 449 (LSP: 1171). *Systema* 3: index, 25 leads to Linnaeus, although *Systema* I: 56 does not, devalidating *A. integer* as earlier typonym.

70. *Systema* I: 40 is a homonym of *Systema* I: 65. Under ICBN, one, must be chosen, the other devalidated.

71. New name for *A. nimbatus* BEFC I: 49, devalidated under ICBN.

72. New name for *A. echinatus* SEF: p.f.p. 99, devalidated under ICBN. *A. echinatus* Roth. Cat. 2: 155 is adopted in *Systema* I: 286.

73. In *Systema* as "*melizius*".

74. New name for *A. dicolor* PS: 462, devalidated under ICBN, without inclusion of FOM I: 80 in protologue.

75. New name for *A. eburneus* Bolt.: 4. Not only is Bolton's name priorable, but sanctioned in *Systema* I: 33.

76. New name for *A. granulatus* Sch 4: 11, devalidated under ICBN.

77. Also cited in FOM I: 53 with same protologue.

78. New name for *A. scaber* FD 14: t. 832, which is not only priorable, but sanctioned in *Systema* I: 255.

79. New name for *A. varius* Sch 4: 20, which is not only priorable, but sanctioned in *Systema* 1: 225.

80. New name for *A. luteus* Bolt: 50. In *Systema* 1: 244, this name is part of protologue of a variety only, and FOM 2: 12 is cited as protologue for a different variety. The species epithet (*A. muricatus*) is cited without protologue, leading one to conclude that the variety with FOM 2: 12 as protologue is the type variety. So far as I know, no provision is made in ICBN for such situations.

81. New name for *A. circumseptus* BEFC 1: 119. In *Systema* 1: 246, *A. mycenoides* is without protologue, including FOM and BEFC. I interpret that *A. mycenoides* FOM 2: 38 is an earlier homonym of a sanctioned name (*A. mycenoides* Fr 1: 246), and that *A. circumseptus* BEFC 1: 119 is priorable under the ICBN.

82. New name for *A. brunneus* Sch 4: 16, not included in protologue of *Systema* 1: 35. *Systema* 3: index, 10, indicates synonymy under *A. callosus Syst.* 1: 292, but that protologue also omits it. I judge Schaeffer's name to be priorable.

83. In *Systema* 1: 162, sanctioned as tribus.

84. New name for *A. caespitosus* Bolt: 41, dubiously devalidated under ICBN.

85. In *Systema* as "*oreinus*".

86. In *Systema* as "*pargamenus*".

87. New name for *A. violaceus* SEF: p.f.p. 209, devalidated under ICBN.

88. New name for *A. rufipes* PID: 4, devalidated under ICBN. In *Systema* as "*petiginosus*".

89. New name for *A. glandifer* BEFC 1: 99. In *Systema*, Fries distances from this synonymy, making Batsch's name priorable.

90. New name for *A. phialea* SAE 2: 297, used in *Systema* 1: 166, only at varietal rank, so Schumacher's name is priorable. See note 89.

91. New name for *A. mutabilis* BEFC 2: 38, sanctioned at variety rank in *Systema* I: 245.

92. New name for *A. alliaceus* BH: 551, devalidated under ICBN. In FOM I: 30, *A. alliaceus* is adopted with Jacquin as authority.

93. New name for *A. alliaceus* Scop 2: 454, devalidated under ICBN. In FOM I: 30, Fries cited *A. porreus* PS: 376, but in *Systema*, Fries distances from this synonymy, but cites FOM I: 30 in protologue.

94. New name for *A. subpurpurascens* BEFC I: 71, which is priorable at species rank. In *Systema* I: 34, Fries cites *A. purpurascens* with A&S: 182 as authority.

95. New rank and name for *A. purpureus* SAE 2: 235, which is priorable.

96. In *Systema*, cited with no protologue, including FOM.

97. In *Systema* I: 30, the variety is raised to *A. rhagadiosus*, but FOM epithet is priorable at varietal rank.

98. New name for *A. roseus* PS: 393, devalidated under ICBN. In *Systema* as "*rosellus*".

99. New name for *A. repandus* Bolt: 6, devalidated under ICBN.

100. In *Systema* I: 54, sanctioned as tribus.

101. Incorrectly cited with Schaeffer as authority.

102. New name for *A. fusiformis* SAE 2: 318, which is devalidated under ICBN as a synonym of *A. myomyces* PS: 345: Fr. I: 44.

103. FOM epithet cited under var. b only in *Systema* I: 223.

104. New name for *A. fagineus* SAE 2: 330, devalidated under ICBN.

105. New name for *A. schaefferi* POM 2: 55, devalidated under ICBN.

106. New name for *A. semiglobatus* SEF: p.f.p. 240, taken up as a synonym of *A. callosus* (var. b) in *Systema* I: 292.

107. In Systema I: 196, proposed at species rank.

108. In Systema I: 196, replaced by A. sericellus.

109. New name for A. serrula PS: 463, devalidated under ICBN.

110. New name for A. pubescens SEF: p.f.p. 321, taken up as synonym of A. septicus in Systema I: 192.

111. New name for A. araneosus SEF: p.f.p. 384, devalidated under ICBN.

112. New rank and name for A. prunulus Scop 2: 437.

113. New rank for A. spongiosus SAE 2: 311.

114. PS: 409 cited in synonymy under variety a in Systema.

115. In Systema, PS: 423 cited under var. a only.

116. New rank and name for A. pratensis FOM I: 27.

117. In Systema, FOM I: 39 cited under var. a, PS: 390 cited under var. b.

118. In Systema Fries adds BEFC 2: 27 as authority.

119. Introduced as dubious new name for A. umbrinus PS: 180.

120. In Systema as "trachelinus".

121. New name for A. amethystinus Sch: index, p. 24, devalidated under ICBN.

122. New rank and name for A. turbinatus SAE 2: 317.

123. In Systema as "turbinatus".

124. New rank and name for A. olivaceus SAE 2: 246.

125. New name for A. nigrella A&S: 222. In Systema, Fries distances from this synonymy, thereby making A. nigrella priorable. In Systema as "atratus".

126. New name for A. livido-rufescens BEFC 2: 202, devalidated under ICBN.

127. New rank and name for A. atro-cinereus β medius A&S: 175.

AMANITA

128. In Systema as Agaricus. PS as Amanita, AGS as Agaricus.

129. In Systema as Agaricus.

130. In Systema as Agaricus. New name for A. pubescens Sae 2: 227, devalidated under ICBN.

AREGMA

131. In Systema as Phragmidium.

ASTEROPHORA

132. New name for Agaricus lycoperdoides Dittmar, devalidated under ICBN.

133. In SEF as Agaricus "lycoperdonoides". For Fries, not a synonym of Agaricus lycoperdoides Dittmar (see note 132).

BOLETUS

134. In FOM these names are separated (as homonyms), but in Systema are both cited as protologue for a common B. luteus.

135. New name for B. olivaceus Sch 4: 77, devalidated under ICBN.

136. In Systema as Sistotrema.

CERATOSTOMA

137. New name for Ceratospermum Micheli. Not sanctioned in Systema.

138. In Systema as Sphaeria.

CLAVARIA

139. New name for *C. coralloides* SEF: 115, taken up as a synonym of *C. rugosa* in *Systema* 1: 473.

140. New rank for *C. trunciales* var. *juncea* A&S: 289.

141. Misspelling of *macrorhiza.*

142. New name for *C. rubella* PC: 81, dubiously sanctioned in *Systema* 1: 485.

143. New name for *C. obtusa* SEF: 138, devalidated under ICBN. In *Systema* as *Pistillaria.*

DAEDALEA

144. In *Systema* as *Polyporus.*

DEPAZEA

145. In *Systema* as *Sphaeria.*

DOTHIDEA

146. In *Systema* as *Phacideum.*

ERINEUM

147. Sanctioned in *Systema* 3: 521, but with no sanctioned species. FOM is part of generic protologue, but this does not sanction specific epithets from FOM.

148. New name for *E. tiliaceum* Scheich. sec. spec., which is priorable.

149. New name for *E. betulinum* A&S: 370, which is priorable.

ERYSIPHE

150. New name for *Mucor erysiphe* LFS: 462, which, while valid, would result in a tautonym if transferred to *Erysiphe*. Fries's name, therefore, is not superfluous. Again listed in FOM 2: 366 with FOM 1: 206 as protologue.

GEOGLOSSUM

151. In *Systema* as *Clavaria*.

HELOTIUM

152. In *Systema* as *Peziza*.

HYDNUM

153. In FD, as "*caeruleum*".

154. New name for *H. hybridum* BH: 307.

155. New name for *H. flexuosum* Schleicher.

156. New rank for *H. squamosum* Sch 4: 99.

157. In FOM as dubious species.

158. In *Systema* as *H. violascens*.

HYPOCHNUS

159. In *Systema* as *Thelephora*.

HYSTERIUM

160. In *Systema* as *Stictis*.

LOPHIUM

161. In *Systema* taken up and doubtfully sanctioned under *Sphaeria*.

LYCOGALA

162. Names in this genus are sanctioned through Persoon's *Synopsis*.

MERULIUS

163. In *Systema* as *Cantharellus*.

164. In *Systema* as *Phlebia*.

165. In BH as "tubaeformis".

166. In *Systema* as *Cantharellus*, where FD is not cited as synonym.

MITRULA

167. New name for *Clavaria minuta* SEF: 173, the epithet of which sanctioned in *Systema* 1: 492 (as *Mitrula*). In *Systema* as *Mitrula heyderia* var. *pusilla*.

NAEMASPORA

168. In *Systema* as *Cytispora*.

169. New name for *N. nigra* Rebent. Fl. Neom: 340, devalidated under ICBN.

PEZIZA

170. In *Systema* as *Ascobolus aerugineus*.

171. In *Systema* as subgenus.

172. In *Systema* as genus.

173. In *Systema* at suprageneric rank.

174. In FOM, under *A[scobolus]*, although listed under *Peziza*, and in *Systema*, sanctioned as *Ascobolus*.

175. New name for *Octospora pepiformis* Hedwig, Musc. Frond.: 32, not taken up in *Systema* and therefore priorable.

PHACIDIUM

176. In *Systema* as *Excipula*.

PHYLLERIUM

177. *Genus novus*, sanctioned in *Systema* 3: 523, but there without sanctioned specific epithets.

POLYPORUS

178. Homonym of FOM 1: 125.

179. New name for *Boletus pelleporus* BH: 365 as "pelloporus".

180. New name for *Boletus pelloporus* SEF: 96, a homonym of BH: 365.

181. In *Systema* as *Daedalea*.

POROTHELIUM

182. New name for *Peziza porioides* A&S: 327, sanctioned in *Systema* 2: 111.

RACODIUM

183. In Systema as Sporothricum.

184. New name for R. nigrum Sae 2: 447, and Dematium pinastrum "Scheich. sec. spec.", devalidated under ICBN.

RHIZINIA

185. New name for Octospora rhizophora Hedwig, Descr. Musc. Frond. II: 15, the epithet of which is devalidated under ICBN.

186. New name for Elvella inflata Sch 4: 102, the epithet of which is devalidated under ICBN.

RHIZOMORPHA

187. Not sanctioned in Systema. In FOM, Fries cites Acharius as generic protologue, but indicates that these taxa (or Acharius' proposal of the name) were not seen by Fries.

188. There is an indication that R. filiformis Fr. is a synonym (nom. superfl.) but no protologue to this name is furnished. The name is not taken up in Systema.

189. Rhizomorpha stricta Fries is offered as a synonym, but not sanctioned in Systema.

190. Fries specifically gives his own name as authority, but also cites Achar. VAH 1814: 233. Neither name is sanctioned in Systema.

SCHIZOPHYLLUS

191. New name for Agaricus alneus Linn., GSN: 1431. In Systema cited without protologue.

SCLEROTIUM

192. In *Systema* as *Acrospermum*.

193. New name for *S. villosum* TFM 2: 6. In *Systema*, FOM is protologue, but with no citation of TFM epithet (nor in *Systema* 3: index). Although *Systema* leads only to FOM, and FOM is an illegitimate name (*nomen superfluum*), *tomentosum* is nonetheless *sanctioned* and *villosum* is not, even though indirectly.

SISTOTREMA

194. In *Systema* as *Irpex*.

SPHAERIA

195. In *Systema* as subgenus, sanctioned without circumscription or protologue.

196. In FOM introduced with other dubious species.

197. In *Systema*, protologue is cited as Fries.

198. In *Systema* 2: 521, Fries sanctions *S. hederae* SEF: 154, but without FOM protologue.

199. In *Systema* 2: 490, Fries sanctions *S. lonicerae* SEF: 175, but without FOM protologue.

200. In *Systema* as *Dothidea*.

201. New name for *S. argillacea* PIC: t. 3 fig. 1-3, devalidated under ICBN.

202. In *Systema* as *Dothidea*.

203. In *Systema* as *Phoma*.

204. In *Systema* as *Dothidea*.

205. New name for *S. berberides* Schleich., sanctioned in *Systema* 2: 415.

206. Sanctioned in *Systema* without circumscription or protologue.

207. In *Systema* as *Perisporium*.

208. In *Systema* 2: 500, Fries sanctions *S. taxi* SEF: 176, but without FOM protologue.

209. New name for *S. ochracea* WFL: 518, which is priorable.

SPHAERONEMA

210. New name for *S. dubia* A&S: 50, devalidated under ICBN.

211. Misspelling of *hemisphaerica*.

STEGIA

212. In *Systema* as *Eustegia*.

STEREUM

213. In *Systema* as *Thelephora*.

TAPHRIA

214. New name for *Erineum aureum* A&S: 371, devalidated under ICBN.

THELEPHORA

215. New name for *T. lactea* Schr.: 186, devalidated under ICBN.

216. Introduced dubiously with several "new varieties" but not included under a specific epithet adopted in FOM.

217. New name for *Auricularia laevis* "SEF t. 388 fig. 2" (incorrect citation).

218. New name for *Auricularia papyrina* SEF: 143, and *A. pallida* Sae 2: 398, both devalidated under ICBN.

219. New name for *Auricularia persistens* SEF: 170, devalidated under ICBN.

XYLODON

220. In *Systema* as *Hydnum*.

221. In *Systema* as *Polyporus*.

XYLOMA

222. In *Systema* as *Sphaeria*.

223. In *Systema* as *Sclerotium*.

224. In *Systema* this epithet is sanctioned with Funck as authority and without FOM in protologue.

225. In *Systema* as *Phacidium*.

226. In *Systema* as *Leptostroma*.

227. In *Systema* as *Rhytisma*.

228. In *Systema* as *Ectostroma*.

229. Taken up in *Systema* 2: 576 as synonym of *Phacidium leptideum* Fr., q.v.

230. In *Systema* as *Lasiobotrys*.

231. In *Systema* as *Dothidea*.

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MYCOTAXON

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AN ANNOTATED INDEX FOR JAMES SOWERBY'S "COLOURED FIGURES OF ENGLISH FUNGI"

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Summary

An index to fungus names employed by Sowerby, their status, their history and their fate in sanctioning books, is furnished.

The names and taxonomic concepts originated or used by James Sowerby (born: London, 21.iii.1751; died: Lambeth, 25.x.1822) had lasting influence on subsequent workers and therefore fungus taxonomy. In some genera (e.g. Sphaeria, Aecidium, etc.) several species were described for the first time, but in the fleshy fungi his illustrations were of such high quality that they permitted other workers to identify the taxa involved.

Sowerby was a practiced and trained artist-illustrator, although he apparently took botany courses (cf. Killermann, 1929). Accordingly, he penned: "It is indeed easier to describe or draw an individual variety than to ascertain to what species it belongs." Coincidentally, in the many fascicles of plates and text comprising the "Coloured Figures" series (Sowerby, 1797-1809), the plates were numbered but the text not so. The result has been that later references to Sowerby's major mycological publications have been universally to plate numbers. Such citations being incomplete (the name and circumscription are vital for valid publication), the index below has been compiled.

Sowerby was prodigious in his illustrations. As an advertisement appended to his elucidation of colours (Sowerby, 1809), an annotated list of his own prior publications was furnished, including "British Minerology", "Sowerby's English Botany" (210 numbers!), "British Miscellany" of rare animal subjects, "Exotic Botany", "Crystallography", and "A Botanical Drawing Book" (in two editions). In addition, he furnished illustrations to other published works, such as J.E. Smith's several large works, including 36 volumes of "English Botany", Aiton's "Hortus Kewensis", Woodville's "Medical Botany" and Dickson's "Plantarum Cryptogamicarum Britanniae".

W.G. Smith (1905a-f), who had ready access to Sowerby's drawings at the British Museum (Natural History) for many years, critically appraised them and published annotations. Three aspects are especially noteworthy. First; Smith offered his identification of Sowerby's drawings, but they must not be taken as authoritative, any more than those of any other author. Second; Smith drew attention to changes from original to published illustration and to additional notes by Sowerby which showed some of Fries's identifications of Sowerby's plates to be erroneous. Fries's adoption of Sowerby names may represent misapplications, therefore, and Sowerby names placed as synonyms by Fries may represent taxa other than those under which they were placed. Third; Smith's introduction (1905a) bears reading for its own sake.

Stafleu (1967) and Ramsbottom (1933) furnished a schedule of dates of appearance of the 32 fascicles of plates and the four volumes (three numbered, plus a supplement) of text. The text was issued much less frequently, and covered many plates. For nomenclatural purposes, it is the text and its circumscriptions which create the names new to Sowerby, whether of new taxa or simply new names for previously named taxa.

In order to make better use of this index, the schedule of appearance of text pages was as follows:

Preface + pp. 1-52. Dated Sept. 1797;
pp. 53-100. Dated 1799;
pp. 101-188. Dated 1803;
pp. 189-206. Dated April 1, 1809.

Ramsbottom (1933) reported that a mint condition copy of "English Fungi" included paper with watermarks considerably younger than the dates on the fascicles. He reasoned that Sowerby may have had printed fascicles of plates as he needed them for subscribers, using general stocks of paper available to him. While this does not alter the original dates or names, it could be anticipated that the colors of the various printings (only two of which are known, but more may exist) may vary, both originally and through time. The fastidious taxonomist may, therefore, wish to examine more than one copy of the work for the sake of accuracy.

Here and there (Sowerby, preamble to vol. 3; Smith, 1945a) one finds mention of wax models of fungi fashioned by Sowerby.

These resided with his sons (as did his herbarium, drawings, paintings, and other memorabilia), passed into the hands of Miles Joseph Berkeley, and were eventually presented to the British Museum (Natural History). The models were destroyed during World War II, but his drawings survived. I do not know of the disposition of his herbarium.

In "Coloured Figures", Sowerby provided indexes to names as they appeared in plates, but not to names in the text. Thus significant numbers of names do not appear in the index at all, others occur throughout the text, with only a single entry in the index, etc., etc. The following guide to the form of Sowerby's indexes may be offered.

1. Names in italic type (i.e. *Aecidium fuscum*); Sowerby's name of choice. Numerous names of choice however, appear in Roman type, presumably as a *lapsus calami*.

2. Names in Roman type (i.e. Agaricus annularius): either a) a synonym of a name of choice, or b) a name mentioned in the text accompanying the plate cited (in this index cited as text and/or plate number underlined).

3. Names in Roman type together with authority (i.e. Agaricus androsaceus, Bull.): a synonymous name added by Sowerby presumably after writing the text, and appearing only in the index. These entries are often accompanied by a partial citation as well (i.e. Boletus aureus Schaeff. 115).

Finally, in the wake of nomenclatural changes made in 1981, it is important to know which Sowerby names were sanctioned by Fries or Persoon. That number seems astonishingly low unless Killermann (1929) is correct that Sowerby's work was not available in Germany except in Berlin and not in Lund, Sweden, where Fries compiled most of at least volume one of *Systema Mycologicum*.

The Index

Column 1. The names of organisms listed alphabetically regardless of genus or rank, as they appear in SEF. Included are *all* names — those adopted as well as those in synonymy and those in footnotes or index only.

Column 2. The page on which the name appears. When a name appears only in a legend of a plate, the page column remains blank.

Ind. = a name with major or sole mention in Sowerby's index (e.g. *caryophyllea, Helvella*).

000 = a name mentioned *in observationes* (e.g. *meliagris, Agaricus*).

Column 3. The plate(s) in which Sowerby represented the fungus the name of which is in column 1.

000.0 = plate and figure (e.g. *carbonaria, Farinaria*; plate 396, fig. 4).

000 = a name mentioned or cited in the legend of a plate (e.g. *infundibuliformis, Agaricus*).

"000" = names listed in Sowerby's index were often referenced to a plate where that name does not appear. These names may have been added late, but sometimes also appear in the text, and there almost always with no reference to an illustration (e.g. *inodorus, Agaricus*).

Column 4: Citation of any particular status of the name.

sp. nov. = new species, according to Sowerby. Often this is my interpretation caused by Sowerby's lack of any attribution for the name, and when this is true, it is reflected in the explanatory notes.

pro syn. = mentioned by Sowerby only in synonymy under a name which he adopted.

nom. nov. = Sowerby furnished a binomial name for a taxon previously represented only by a polynomial.

comb. nov. = Sowerby adopted a prior epithet, but transferred it to a new position.

nom. superfl. = Sowerby furnished a new binomial for an organism already provided with a binomial, as deduced from Sowerby's own citations and text.

Column 5. The number of the appropriate explanatory note which deals with this name.

Column 6. Location in Fries's Systema Mycologicum where Sowerby name is sanctioned. No Sowerby names of rusts, smuts or gastromycetes seem to have been sanctioned by Persoon.

Explanatory Notes

1. All literature abbreviations are taken from Petersen's (1975, etc.) series of publications on 1821 names. Some of the most common are:

WBA: Withering's Botanical Arrangement;
With: Withering's Systemic Arrangement;
LSP: Linnaeus's Species Plantarum (1753);
LSpPl: Linnaeus's Species Plantarum, 2nd ed. (1763);
Bolt: Bolton's History of Fungusses;
Sch: Schaeffer's Fungorum in Bavaria;
Scop: Scopoli's Flora Carniolica, 2nd ed.;
BH: Bulliard's Histoire;
HFA: Hudson's Flora Anglica.

2. The literature source providing a name used by Sowerby and cited by him is furnished, as well as prior sources. Not all sources are listed in the explanatory notes, for in many instances they were too numerous and often did not include the name adopted by Sowerby.

The bibliographic history of the name is sketched by linking the sources with " ← ".

Often one of the sources listed by Sowerby leads to an earlier source not listed by Sowerby. The latter source is placed in square brackets. For example, in note 2:

Sowerby cites both WBA and BH, which are here placed in chronological order. BH leads to LSP, not cited by Sowerby so here furnished in square brackets.

3. Often a name adopted by Sowerby was based on a prior nomen superfluum. This situation is outlined in the appropriate note. For example, in note 3:

Sowerby cites Schaeffer as authority for A. acicula, but Schaeffer's name is a nomen superfluum (by his own citations), for Scopoli's A. coccineus. Because Sowerby does not cite Scopoli, that information is enclosed in square brackets.

4. Smith's five-part series (see introduction) included his interpretation of Sowerby's plates. These are furnished in appropriate notes. For example, in note 3:

In part four of Smith's series (SIV), he concludes that Sowerby's plate represents *Agaricus* (*Galera*) *hypnorum* Batsch.

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acetabulosus, Agaricus	125	303	sp. nov.		
acetabulum, Peziza	28	59		2	
acicula, Agaricus	117	282		3	
aciniformis, Sphaeria	114	273	sp. nov.		
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aculeiformis, Clavaria	20	"40"	pro syn.	5	
acuminata, Sphaeria	176	394.3	sp. nov.		Fr 2: 506
acuminatus, Agaricus	---	131		6	
acuta, Clavaria	138	333	sp. nov.	7	Fr 1: 485
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araneosus, Agaricus	165	384.1, 11, 223	sp. nov.	34	
arboreus, Boletus	142	346	sp. nov.	35	
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argillacea, Peziza	64	148	sp. nov.		Fr 2: 66
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arundinacea, Sphaeria	139	336	sp. nov.		Fr 2: 429
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auurantiacus, Boletus	48	110		43	
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aurea, Sphaeria	146	356	sp. nov.	
aurea, Uredo	132	320	sp. nov.	
aurea, Peziza	64	150	comb. nov.	45
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aureus, Boletus	ind.	"34"		47
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bicolor, Peziza	11	17		56
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cancellatum, Lycoperdon	191, ind.	"409"	pro syn.	78
cancellatus, Mucor	---	259		79
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caninus, Phallus	136, ind.	"330"	pro syn.	81
cantharelloides, Agaricus	23	47		82
cantharelloides, Helvella	ind.	"47"		
cantharellus, Agaricus	23	46, 413		83
cantharellus, Merulius	ind.	"46"		
capsuliferum, Lycoperdon	201	425	sp. nov.	84
carbonaria, Farinaria	178	396.4	sp. nov.	
cardui, Aecidium	180	398.5	sp. nov.	
carnosa, Reticularia	182	399.3		85
carnosus, Agaricus	103	246		86
carpina, Sphaeria	160	376	sp. nov.	

carpineus, Boletus	97	231	nom. nov.	87	
carpobolus, Lycoperdon	13	22, 23		88	
cartilaginea, Peziza	151	369.2		89	
caryophyllea, Auricularia	89	213, 242		90	
caryophyllea, Helvella	89,ind.	"213"	pro syn.	91	
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caulicinalis, Agaricus	69	163		93	
cellularia, Peziza	41	91	nom. nov.	94	
cepaeforme, Lycoperdon	---	332		95	
cepaestipes, Agaricus	5	2	sp. nov.	96	Fr I: 280
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cerea, Reticularia	182	399.4		100	
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cervinus, Agaricus	---	108			
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cinerea, Sphaeria	157	373.11	nom. nov.	109	
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circumvallata, Sphaeria	156	373.4	sp. nov.		

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clavata, Sphaeria	67	159	sp. nov.	115	
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collariatus, Merulius	42, ind.	"95"		127	
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corni, Sphaeria	152	370.5	sp. nov.	
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crispa, Peziza	202	407	sp. nov.	153	
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digitata, Sphaeria	32, ind.	"69"	pro syn.	172	
domestica, Peziza	144	351	sp. nov.		
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dubia, Sphaeria	160	375.7	sp. nov.		

dulcis, Agaricus	---	204		174	
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eburneus, Agaricus	ind.	"32"			
echinatus, Agaricus	44	99	sp. nov.	175	
echiniformis, Lycoperdon	182	400.1		176	
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epidendrum, Lycoperdon	182	400.2		186	
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ferruginea, Clavaria	38	84	sp. nov.		
ferrugineus, Boletus	ind.	"34"		199	
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fragiformis, Sphaeria	107	256		222	
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fragilis, Rhizomorpha	44, ind.	"100"	pro syn.	224	
fragilis, Sphaerocarpus	116	279	sp. nov.		
fragrans, Agaricus	8	10		225	
fraxinea, Sphaeria	68	160, 374.8		226	
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fuliginosa, Sphaeria	157	373.9	sp. nov.		
fuliginosum, Lycoperdon	107	257	sp. nov.		
fulva, Mucor	182	400.4	sp. nov.		
fulvus, Agaricus	---	286		230	
fulvus, Mucor	161	378.8	sp. nov.	231	
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fuscipes, Agaricus	142	344	sp. nov.	235	
fuscipes, Mucor	161	378.3	sp. nov.		
fusco-albus, Boletus	200	421	sp. nov.	236	
fusco-marginata, Sphaeria	175	394.1	sp. nov.		
fusco-pallidus, Agaricus	---	101		237	
fuscum, Aecidium	25	53		238	
fuscum, Lycoperdon	ind.	"272"			
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graveolens, Agaricus	117	281		258	
gregaria, Sphaeria	159	375.5		259	
gutta, Sphaeria	175	393.5	sp. nov.		
harrimani, Rhizomorpha	203	431.1	sp. nov.		
hederae, Sphaeria	154	371.5	sp. nov.		Fr 2: 521
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hirsuta, Sphaeria	167	386.3	sp. nov.		Fr 2: 450
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hortensis, Reticularia	181	399.1		273	
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hybrida, Peziza	151	369.1	sp. nov.		
hybrida, Rhizomorpha	174	392.3	sp. nov.		
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hydnoides, Peziza	75	178	sp. nov.		
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hydrophorum, Lycoperdon	14	23		276	
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imbricatum, Hydnum	34	73, 267		282	
imbricatus, Boletus	39	86		283	
immersa, Peziza	171	389.2	sp. nov.	284	Fr 2: 154
immersa, Peziza	152	369.9	sp. nov.	284	Fr 2: 154

immersa, Sphaeria	157	374.1	sp. nov.		Fr 2: 358
imperialis, Agaricus	---	286		285	
imperialis, Rhizomorpha	202	409	sp. nov.		
impuber, Agaricus	54	125		286	
impuber, Boletus	82	195	sp. nov.	287	
impudicus, Phallus	136, ind.	"329"	pro syn.	288	
incrassatus, Agaricus	197	415	sp. nov.	289	
inflexa, Peziza	127	306		290	
infundibuliformis, Agaricus	79	186, 142	pro syn.	291	
infundibuliformis, Elvella	ind.	"3"		292	
infundibuliformis, Helvella	65	153		293	
inodorus, Agaricus	54,ind.	"124"	pro syn.	294	
inodorus, Phallus	136	330			
inornatus, Agaricus	141	342	sp. nov.	295	
insidiens, Sphaeria	155	372.12	sp. nov.		
irregularis, Boletus	200	423	sp. nov.	296	
irregularis, Sphaeria	158	374.9	sp. nov.		Fr 2: 361
integer, Agaricus	85	201		297	
kirbii, Sphaeria	153	371.3	sp. nov.		
laccatus, Agaricus	87, ind.	"208"	pro syn.	298	
laceratum, Aecidium	131	318	sp. nov.		
lachrymans, Boletus	49	113, 214, 289, 387.8, 403		299	
laciniata, Clavaria	67	158		300	
lacrymabundus, Agaricus	21	41		301	
lactifluus, Agaricus	86	204		302	
lactifluus-acris, Agaricus	---	245			
lactifluus, Boletus	199	420	stat. nov.?	303	
lacunosum, Sclerotium	---	287		304	
lacunosus, Lycoperdon	---	332		305	

laevis, Auricularia	171	388.2		306	
laevis, Nidularia	16	30	comb. nov.	307	
laevis, Sphaeria	176	394.5	sp. nov.		
lamellosus, Merulius	186	403	sp. nov.		
lanata, Farinaria	163	379.5	sp. nov.		
lanatus, Agaricus	198	417	sp. nov.		
lanuginosa, Peziza	63, ind.	"147"	pro syn.	308	
lateralis, Agaricus	---	109		309	
lateralis, Boletus	ind.	"89"		310	
latus, Agaricus	47	108		311	
latus, Boletus	169	387.9	sp. nov.		
lauri, Sphaeria	153	371.4, 372.1	sp. nov.		
lentifera, Peziza	15, ind.	"28"	pro syn.	312	
lentifera, Peziza	16	---		313	
leporina, Peziza	36	79		314	
leucocephalus, Agaricus	---	249		315	
lichenoides, Sphaeria	157	373.12	sp. nov.	316	
licheniformis, Sphaeria	92	220	sp. nov.		
lignifragus, Mucor	162	378.14	sp. nov.	317	
lignosa, Clavaria	---	382		318	
limacinus, Agaricus	7	8		319	
listeri, Agaricus	46	104		320	
listeri, Agaricus	102	245		321	
lividus, Agaricus	ind.	"108"			
lobatus, Agaricus	79	186	nom. superfl.	322	
loculiferum, Hypoxylon	84, ind.	"200"		323	
longa, Sphaeria	175	393.4	sp. nov.		
longipes, Agaricus	23, ind.	"48"		324	
longissima, Uredo	60	139	sp. nov.		
lonicerae, Sphaeria	175	393.6	sp. nov.		Fr 2: 492

lucidus, Boletus	58	134		325	
luridus, Boletus	104	250	pro syn.	326	
lutea, Reticularia	181	399.2		327	
luteus, Agaricus	5, ind.	"2"	pro syn.	328	
luteus, oletus	110	265		329	
lycoperdoides, Sphaeria	113, ind.	"271"		330	
lycoperdon, Reticularia	113	272		331	
lycoperdonoides, Agaricus	165	383, 400.10		332	
macula, Sphaeria	157, ind.	"373.11"	pro syn.	333	
macularis, Sphaeria	177	394.9	sp. nov.		
maculatus, Agaricus	---	286			
marginata, Peziza	11	16		334	
marginata, Sphaeria	155	372.7	sp. nov.		
martini, Rhizomorpha	203	431.3	sp. nov.		
maxima, Sphaeria	139	338		335	
maximum, Lycoperdon	---	332		336	
medulla panis, Boletus	135	326, 289		337	
melastoma, Peziza	64	149	sp. nov.		Fr 2: 80
meliagris, Agaricus	73, 14	171		338	
melleus, Agaricus	---	101		339	
membranacea, Helvella	143	348, 411		340	
membranacea, Merulius	143	---	pro syn.	341	
membranaceum, Hydnum	135	327		342	
membranaceus, Merulius	ind.	"348"			
menthae, Aecidium	180	398.3	sp. nov.		
mesenterica, Tremella	---	294			
mesentericus, Boletus	ind.	"86"		343	
meteorica, Tremella	---	435			
meteorica, Trichia	204	435	comb. nov.	344	
micaceus, Agaricus	---	261			

militaris, Clavaria	ind.	"60"			
militaris, Sphaeria	28	60		345	
millus, Agaricus	78	184	sp. nov.		Fr I: 93
miniatus, Agaricus	61	141		346	
minor, Sphaeria pustulata var.	ind.	"370.4", 375.4, 375.1			
minuta, Clavaria	173	391	sp. nov.		Fr I: 492
minuta, Nidularia	ind.	"239"			
minuta, Puccinia	184	400.10	sp. nov.		
minuta, Trichia	ind.	"239"			
minuta, Sphaeria pustula var.	159	375.1	var. nov.		
minutus, Cyathus	100	239		347	
minutus, Nidularia	100	---	pro syn.	348	
minutus, Trichia	100	---	pro syn.	349	
minutissima, Sphaeria	152	370.1		350	
mitra, Helvella	20	39		351	
mollis, Agaricus	43	98, 185		352	
molluscus, Agaricus	74	174	sp. nov.	353	
momentaceus, Agaricus	---	262		354	
monacella, Elvella	ind.	"39"		355	
monstrosus, Agaricus	117	283	sp. nov.	356	
mori, Sphaeria	106	255		357	
moschatum, Tuber	201	406		358	
mucedo, Mucor	161, ind.	378.5-7, "387.6-10"	sp. nov.	359	
mucilago, Spumaria	---	280		360	
multicapsula, Reticularia	76	179	sp. nov.		
multicapsula, Rhizomorpha	---	272			
multicapsula, Sphaeria	205	436	sp. nov.		

multiceps, Sphaeria	176	394.8	sp. nov.		
muralis, Agaricus	133	322	sp. nov.	361	Fr 1: 165
muralis, Peziza	105	251	sp. nov.		
murinus, Agaricus	68	162	sp. nov.	362	
murinaceus, Agaricus	47	106		363	
muscarius, Agaricus	119	286, 130, 202, 245 ftnt.		364	
muscoides, Clavaria	67	157		365	
nicotiana, Auricularia	ind.	"25"			
nidula, Sphaeria	175	394.2	sp. nov.		Fr 2: 418
niger, Peziza	151	369.8	sp. nov.	366	
nigra, Peziza	127	307	sp. nov.	367	
nigra, Sphaeria	174	393.1	sp. nov.		
nigricans, Agaricus	ind.	"36"		368	
nigricans, Elvella	ind.	"39"		369	
nigripes, Agaricus	ind.	"263"			
nigrum, Hysterium	156, ind.	"373.3"		370	
nitens, Agaricus	33	71, 407		371	
nitida, Sphaeria	114	275		372	
nivea, Peziza	30	65		373	
nivea, Sphaeria	92	219		374	
niveus, Agaricus	43, ind.	97, "32"		375	
nostoc, Tremella	----	435			
nuda, Trichia	24	50, 435		376	
nudus, Agaricus	---	223		377	
nudus, Clathrus	ind.	"50"			
nummularium, Hypoxylon	ind.	"137"			
nummularius, Boletus	40	89		378	
nutans, Agaricus	41	92	sp. nov.	379	
nutans, Trichia	108	260		380	

obliquatus, Boletus	58, ind.	"134"		381	
oblonga, Sphaeria	158	374.7	sp. nov.		
obscurus, Agaricus	---	77		382	
obsoletus, Agaricus	---	223		383	
obtusa, Clavaria	138	334	sp. nov.	384	
ochroleuca, Elvella	ind.	"4"		385	
ochroleuca, Peziza	50	115		386	
odorus, Agaricus	21	42		387	
ollaris, Peziza	ind.	"30"		388	
opacus, Agaricus	61	142		389	
ophioglossoides, Clavaria	37	83, 353		390	
oreades, Agaricus	103, ind.	127, 142, 407, "247", 408	pro syn.	391	
ostracia, Hypoxylon	160	---	pro syn.	392	
ostracia, Sphaeria	160	375.9	comb. nov.	393	
ostreatus, Agaricus	101	241		394	
ovatus, Agaricus	79, ind.	"188"	pro syn.	395	
pallida, Elvella	ind.	"39"		396	
pallidus, Agaricus	150	365	sp. nov.	397	
pallidus, Agaricus	61	143		398	
palmatus, Agaricus	29	62		399	
pannosa, Helvella	66	155	sp. nov.		Fr I: 430 (Thelephora)
papillaria, Peziza	75	177		400	
papillionaceus, Agaricus	ind.	"131"			
papillosa, Sphaeria	99	236	sp. nov.		
papyrina, Auricularia	143	349		401	
parallela, Sphaeria	158	374.4	sp. nov.		
parasitica, Sphaeria	167	386.2	sp. nov.		
parasiticus, Agaricus	141	343	sp. nov.	402	

parasiticus, Botritus	147, ind.	"359", 340	pro syn.	403	
parvus, Agaricus	22, ind.	"45"	pro syn.	404	
patens, Rhizomorpha	173	392.1	sp. nov.		
pedicillata, Peziza	151	369.1	nom. nov.	405	
pedunculata, Sphaeria	205	437		406	
pedunculatum, Lycoperdon	188	406		407	
pelloporus, Boletus	96	230		408	
perennis, Boletus	81	192		409	
perforata, Sphaeria	154	372.2	sp. nov.		Fr 2: 411
peronatus, Agaricus	19	37		410	
persistens, Auricularia	170	388.1		411	
pertusum, Lycoperdon	195	412.2	sp. nov.		
phacorhiza, Clavaria	97	233, 232		412	
phaiopodius, Agaricus	ind.	"66"		413	
phalloides, Clavaria	121, ind.	"293"		414	
phalloides, Lycoperdon	172	390, 11, 145		415	
phosphorea, Auricularia	144	350	nom. nov.	416	
phosphorea, Byssus	144, ind.	"350"	pro syn.	417	
phosphorea, Clavaria	44	100	sp. nov.		
picaceus, Agaricus	72	170		418	
picea, Sphaeria	158	374.5	sp. nov.		
pileolaris, Agaricus	29	61		419	
pilosus, Agaricus	70	164		420	
piperatus, Agaricus	---	245, ftnt			
piperatus, Boletus	18	34		421	
pisi, Sphaeria	175	393.8	sp. nov.		Fr 2: 509
pisiformis, Lycoperdon	---	272, 374.8		422	
pistillaris, Clavaria	98, ind.	"235, 253"	pro syn.	423	
pistillaris, Clavaria	105	---	pro syn.	424	
pixidata, Elvella	ind.	"4"		425	

planus, Agaricus	149	362	sp. nov.		
plicatilis, Agaricus	149	364		426	
plumbeus, Agaricus	ind.	"I", 245, 249, 286		427	
poae, Farinaria	179	396.6	sp. nov.		
polygrammus, Agaricus	92	222, 385		428	
polymorpha, Clavaria	115	276	sp. nov.		
polymorpha, Peziza	202	408		429	
polymorpha, Trichia	76	180	sp. nov.		
polymorphus, Boletus	---	266		430	
pomacea, Farinaria	163	379.1			
populi, Sphaeria	157	374.2	sp. nov.		Fr 2: 547 (Phoma)
porri, Uredo	194	411	sp. nov.		
potentillae, Sphaeria	152	370.2			
pratensis, Agaricus	103	247, 127		431	
procerus, Agaricus	80	190		432	
procerus, Boletus	---	110			
profusa, Sphaeria	160	377	sp. nov.		
proliferus, Agaricus	72	169	sp. nov.	433	
proteus, Lycoperdon	137	332, 331	sp. nov.	434	
pseudo-igniarius, Boletus	---	133			
psittacinus, Agaricus	37	82		435	
pteridis, Sphaeria	177	394.10	sp. nov.		
pubescens, Agaricus	133	321		436	
puella, Agaricus	---	286		437	
pullus, Agaricus	ind.	"48"		438	
pulverulenta, Auricularia	90	214	sp. nov.		Fr El I: 60 (Merulius)
pulverulenta, Fibrillaria	204	433	sp. nov.		
pumilis, Agaricus	166	385.4		439	

punctata, Elvella	ind.	"74"		440	
punctata, Peziza	---	18			
punctata, Sphaeria	26	54	comb. no.	441	
punctata, Sphaeria	159	375.6	sp. nov.	442	
punctata, Variolaria	ind.	"216"			
punctata, Verrucaria	---	375.6			
punctum, Sphaeria	155	372.9	sp. nov.		
purpurascens, Agaricus	---	72		443	
purpurea, Tremella	---	294		444	
purpureus, Merulius	ind.	"74"		445	
pustulata, Sphaeria	152	370.4	sp. nov.	447	
pustulatus, Agaricus	---	286		446	
pyri, Cancellaria	ind.	"409"			
pyriforme, Lycoperdon	---	332		448	
pyriformis, Sphaerocarpus	183	400.6	sp. nov.	449	
quercinus, Agaricus	77	181		450	
quercinus, Boletus	---	228		451	
quernea, Mucor	162	378.12	sp. nov.		
querneus, Agaricus	---	358		452	
racemosus Agaricus	119	287	sp. nov.		
radiatum, Lycoperdon	62	145, 374.8	sp. nov.		
radiatus, Boletus	83	196	sp. nov.		Fr 1: 369 (Polyporus)
radicatus, Agaricus	23	48		453	
radiculata, Peziza	50	114	sp. nov.		Fr 2: 81
ramosa, Sphaeria	177	395.1, 437		454	
ramosissima, Fibrillaria	168	387.2	sp. nov.		
ramosissimus, Boletus	ind.	"87"		455	
ramosum, Hydnum	105, ind.	"252"	pro syn.	456	
ramosus, Boletus	---	135		457	

rangiferinus, Boletus	---	266		458
ranunculi, Aecidium	179	397.4	sp. nov.	
recolligens, Lycoperdon	36, 185	80, 401, 312		459
recta, Sphaeria	176	394.7	sp. nov.	
recutitus, Clathrus	---	259		460
reflexa, Auricularia	15	27, 290, 388.1,2		461
relhani, Helvella	9	11	sp. nov.	
repandum, Hydnum	75	176, 252		462
reptans, Sphaeria	177	395.2	sp. nov.	
resupinatus, Boletus	201	424, 195 ftnt.		463
reticulatus, Agaricus	---	289		464
retiruga, Helvella	143, ind.	"348"	pro syn.	465
rhei, Aecidium	181	398.6	sp. nov.	
rimosa, Peziza	152	369.12	sp. nov.	
rimosa, Sphaeria	159	375.3		466
rimosus, Agaricus	133	323		467
rosae, Uredo	181	398.8	sp. nov.	
rosea, Farinaria	148	360.3	sp. nov.	
rosea, Monilia	162, ind.	"378.11"	pro syn.	468
roseus, Agaricus	33	72		469
roseus, Mucor	162	378.11	comb. nov.	470
rotula, Agaricus	42	95		471
rubeolarius, Boletus	104	250		472
rubi, Aecidium	180	398.1	sp. nov.	
rubi, Puccinia	183	400.9	sp. nov.	
rubiformis, Sphaeria	156	373.2	sp. nov.	
rubiginosa, Helvella	ind.	"26"		
rufus, Agaricus	---	363		473
rugosa, Clavaria	187	404	sp. nov.	474
rugosa, Clavaria	98	235	sp. nov.	475

rugosa, Peziza	151	369.3	sp. nov.		
rugosus, Boletus	200, ind.	422, "134"	sp. nov.	476	
rugosus, Boletus	58	---	pro syn.	477	
rumicis, Aecidium	187	405	sp. nov.		
rupestris, Sphaeria	153	371.2	sp. nov.		
rutilus, Agaricus	46	105		478	
salicina, Sphaeria	154	372.1	sp. nov.		
salicinus, Boletus	95	227, 228		479	
salicis, Aecidium	180	398.4	sp. nov.		
sanguinea, Sphaeria	106	254		480	
sanguineus, Agaricus	22	43		481	
sanguineus, Boletus	---	225		482	
saturnus, Sphaeria	91	218	sp. nov.		
scaber, Agaricus	87	207		483	
scaber, Boletus	74	175, 225		484	
scopula, Sphaeria	167	386.4	sp. nov.		
scrobiculatus, Agaricus	---	103		485	
scutellata, Peziza	14	24, 369.1, 5, 369.10, 11		486	
segetum, Reticula	---	139		487	
sejunctus, Agaricus	54	126	sp. nov.	488	Fr I: 47
semiglobatus, Agaricus	103, 189	248, 324		489	
seminaria, Farinaria	148	360	sp. nov.		
semi-ovatus, Agaricus	56	131		490	
semiovatus, Boletus	---	368		491	
semipetiolatus, Agaricus	48, ind.	"109"	pro syn.	492	
semiputris, Agaricus	56, ind.	"131"	pro syn.		
semitrichoides, Sphaerocarpus	183	400.5		493	
septica, Byssus	---	387.6, 431		494	
sericea, Peziza	ind.	"28"		495	

sericeus, Agaricus	---	363		496	
sessile, Lycoperdon	---	401			
sessilis, Agaricus	43, ind.	"97"	pro syn.	497	
sessilis, Peziza	171	389.1	sp. nov.		
sessilis, Sphaerocarpus	107	258, 279		498	
setosus, Agaricus	125	302	sp. nov.		
simplex, Lycoperdon	---	401.1		499	
sinuosa, Reticularia	7	6		500	
sinuosus, Boletus	82	194	sp. nov.		
solida, Sphaeria	130	314	sp. nov.		
solidum, Tuber	---	311, 376.11		501	
solidus, Boletus	199	419	sp. nov.	502	
solitaria, Sphaeria	---	357	sp. nov.	503	
sordidus, Agaricus	149	363		504	
spadiceum, Lycoperdon	129, ind.	"311"	pro syn.	505	
sparsa, Farinaria	164	380.2	sp. nov.		
spathula, Clavaria	18, ind.	"35"		506	
spatulata, Helvella	18	35	comb. nov.	507	
sphaerocephala, Trichia	100	240	comb. nov.	508	
sphaerocephalus, Clathrus	100, ind.	"240"	pro syn.	509	
sphaerocephalus, Mucor	ind.	"240"		510	
sphaeroidea, Farinaria	178	396.3	sp. nov.		
sphincteria, Sphaeria	166	386	comb. nov.	511	
spiculifera, Sphaeria	114	274	sp. nov.		
spinipes, Agaricus	87	206	sp. nov.	512	
spinosa, Rhizomorpha	124	299, 392.2	sp. nov.		
spireae, Uredo	181	398.7	sp. nov.		
splendens, Agaricus	---	48		513	
spongiosus, Boletus	---	345		514	
spumeus, Boletus	89	211	sp. nov.	515	Fr I: 358

squamosus, Agaricus	ind.	"284", 382		516	(Polyporus)
squamosus, Boletus	111	266		517	
squamula, Agaricus	41	93		518	
squamula, Merulius	41	---	pro syn.	519	
stellariae, Farinaria	178	396.1	sp. nov.		
stellata, Fibrillaria	167	387.1	sp. nov.		
stellatum, Lycoperdon	129	312		520	
stellatum, Lycoperdon	ind.	"80, 312," 401		521	
stercoraria, Peziza	12, 146	18, 357		522	
stercorarius, Agaricus	109	262		523	
stercoria, Peziza	171	389.3	nom. nov.	524	
stipitata, Peziza	20	38, 154		525	
stipitis, Agaricus	45	101, 284, 366		526	
stokesii, Rhizomorpha	203	430	sp. nov.		
striata, Peziza	ind.	"29"		527	
striata, Nidularia	16	29		528	
striatus, Agaricus	71	166		529	
stypticus, Agaricus	48 ind.	"109"	pro syn.	530	
suaveolens, Boletus	95	228		531	
subcantharellus, Agaricus	197	413		532	
subconfluens, Sphaeria	153	370.7	sp. nov.		
subcorticalis, Sphaeria	123	296	sp. nov.		
subdiaphana, Peziza	172	389.4	sp. nov.		
suberosus, Boletus	120	288		533	
subimmersa, Sphaeria	155	372.8	sp. nov.		
subinvolutus, Agaricus	ind.	"61"			
sublamellosum, Hydnum	49	112		534	
sublanatus, Agaricus	94	224	sp. nov.	535	Fr I: 214
subpurpurascens, Agaricus	---	223		536	

subsecreta, Sphaeria	156	373.8	sp. nov.		
subsessilis, Puccinia	184	400.11	sp. nov.		
sulcata, Sphaeria	130	315, 373.3		537	
sulphurea, Farinaria	163	379.3			
sulphureus, Agaricus	22	44		538	
sulphureus, Boletus	58	135		539	
super-crustacea, Sphaeria	159	375.2	sp. nov.		
tabacina, Auricularia	14	25, 27	nom. nov.	540	
taxi, Sphaeria	176	394.6	sp. nov.		Fr 2: 500
tener, Agaricus	17	33		541	
tentaculata, Sphaeria	52	120		542	
tentaculum, Agaricus	166	385.1		543	
tenuis, Agaricus	166	385.5	sp. nov.	544	
tenuis, Clavaria	167	386.5	sp. nov.		Fr 1: 495 (Typhula)
terrestris, Boletus	168	387.5	sp. nov.		
terrestris, Sphaeria	156	373.7	sp. nov.		
terreus, Agaricus	35	76		545	
thlaspi, Uredo	140	340, 359	sp. nov.		
tigrinus, Agaricus	32	68, 382		546	
titubans, Agaricus	55	128		547	
tofieldiae, Sphaeria	152	370.3	sp. nov.		
tomentosus, Agaricus	---	262		548	
torminosus, Agaricus	46	103		549	
tragopoginis, Aecidium	179	397.2		550	
tremelloides, Auricularia	120, ind.	"290"	pro syn.	551	
tremelloides, Peziza	120, ind.	"290"	pro syn.	552	
tremelloides, Sphaeria	---	294, 393.3		553	
tremulus, Agaricus	101	242		554	
trichoides, Mucor	161	378.1,2,4	sp. nov.		

tricolor, Peziza	151	369.6	sp. nov.		Fr 2: 134
trifolii, Farinaria	179	396.7	sp. nov.		
trilobus, Agaricus	ind.	"1"		555	
truncata, Sphaeria	ind.	"54"		556	
tubaeformis, Agaricus	164	382		557	
tubaeformis, Elvella	ind.	"47"		558	
tuberculosa, Sphaeria	158	374.8		559	
tuberosa, Clavaria	84	199	sp.nov.	560	Fr 1: 486
tuberosa, Peziza	30	63, 287		561	
tuberosa, Sphaeria	174	393.2	sp. nov.		
turbinata, Clathrus	38	---	pro syn.	562	
turbinata, Trichia	38	85, 258		563	
turbinatus, Agaricus	45	102		564	
turbinatus, Clathrus	ind.	"85"		565	
turfosus, Agaricus	88	210	sp. nov.	566	
tussilaginis, Aecidium	179	397.1		567	
ulmaria, Sphaeria	157	374.3	sp. nov.		
ulmarius, Agaricus	31	67		568	
ulmarius, Agaricus	165	384.2, 420		569	
ulmarius, Boletus	39	87	sp. nov.	570	Fr 1: 365 (Polyporus)
umbonatus, Agaricus	---	124		571	
umbraculum, Agaricus	---	48		572	
umbrina, Himantia	44, ind.	"100"	pro syn.	573	
ungulatus, Boletus	57, ind.	"132", 133	pro syn.	574	
unicolor, Boletus	134	325		575	
urceolatus, Mucor	124	300		576	
urens, Agaricus	ind.	"81"		577	
ustulatum, Hypoxylon	139, ind.	"338"		578	
utriforme, Lycoperdon	---	332		579	

vaccinii, Sphaeria	156	373.1	sp. nov.		Fr 2: 418
vaccinus, Agaricus	ind.	"101"		580	
vaginatus, Agaricus	---	1		581	
varia, Farinaria	178	396.5	sp. nov.		
variegata, Rhizomorpha	203	431.2	sp. nov.		
variegatus, Boletus	150	368	nom. nov.	582	
variolosum, Lycoperdon	113	271	sp. nov.		
varius, Agaricus	---	222, 385		583	
velatus, Agaricus	7	---	pro syn.	584	
velutinus, Boletus	142	345		585	
velutipes, Agaricus	165	384.3, 48		586	
velutipes, Agaricus	109	263		587	
vermiculata, Clavaria	105	253		588	
vernicosum, Diderma	---	239			
verrucosus, Agaricus	---	286		589	
versicolor, Boletus	96, 169, 150	387.7, 136, 15, 27, 196, 368, 325, 182		590	
vesiculosa, Peziza	6	4, 35, 3		591	
villosus, Boletus	---	345		592	
vinarius, Fibrillaria	203	432	sp. nov.		
vinosus, Agaricus	---	204		593	
violaceus, Agaricus	88	209, 223		594	
violae, Granularia	206	440	sp. nov.		
virgineus, Agaricus	17	32		595	
viridis, Agaricus	---	42		596	
viridis, Sphaeria	160	375.8	sp. nov.		
virosus, Agaricus	189, 190, ind.	407, "408"	nom. nov.	597	
volvaceus, Agaricus	5	1		598	
vulpinus, Agaricus	149	361	sp. nov.	599	Fr 1: 273

xerampelinus, Agaricus	17	31		600
xerompelina, Farinaria	163	380.1	sp. nov.	
zonarius, Agaricus	86	203		601
zylophilus, Agaricus	71	167		602

1. Misnumbered as 389.8 in SEF index; introduced with no circumscription and uncertain position.

2. WBA 3: 436 ← BH: 267← [LSpPl: 1650.]

3. Sch: 52, *nom. superfl.* [≡ *A. coccineus* Scop: 436]. SIV: = *A. (Galera) hypnorum* Batsch.

4. Introduced with no reference to *A. acris* BH: 500 [≡ *A. piperatus* LSpPl: 1641].

5. BH: 214.

6. Sch: [44, pl. 202].

7. SV: = ~~ Sow.

8. Hoffm. 22 ← Relh. Supple. III: 34.

9. BH: 445, *nom. superfl.* ≡ *A. complanatus* Sch. 4: 28 .

10. Dick 2: 24 ← FD: 534.2.

11. CFL 5: 70. S V: = ~ (*Stropharia*) ~ Curt.

12. Bolt. 98.1 ← WBA 3: 430.

13. Bolt. 130 (as "agariciformia").

14. Introduced *in obs.* WBA 3: 289.

15. Introduced with no authority.

16. BH: 92.

17. With 4: 398 ← BH: 137 (*Sphaerocarpus* ~), *nom. superfl.* [≡ *Trichia sphaerocephala* Hoffm., HV 2: 15, t. 14].

18. Sch: 34. SII: = ~ (*Tricholoma*) ~ Fr.

19. *Comb. nov.*; Sch: 101 (*Elvela*).

20. Sch: 84, *nom. superfl.* [≡ *B. flabelliformis* Scop: 465]. SIV: = *Polyporus caesius* Fr.

21. With 4: 371 ← BH: 404.

22. HFA: 626.

23. BH: 551 ← Sch 4: 43 ("alliatus"). SII: = *Marasmius porreus* Fr.

24. LSpPl: 1645. SIII: = *Schizophyllum commune* Fr.

25. With 4: 180 ← BH: 559. SIII: = ~ (*Clitocybe*) *laccatus* Scop.

26. Under Agaricus, Sowerby cites Linnaeus (LSP: 1175). Under *Merulius*, Sowerby cites With 4: 148 and BH: 544 (as pl. 569.2), the latter of which leads to LSP: 1175. The two names would seem to be typonyms. SII: *Agaricus* ~ ss. Sow. = *Marasmius* ~ Fr.

27. Pult. Tr. L. S. 2: 311, but this reference dubious.

28. SIII: = *Daedalea confragrosa* Pers. Fr I: 338 as *Daedalea*.

29. In SEF index (as "annularis") as pl. 265. BH: 316 ≡ *B. luteus* LSP: 1178.

30. With 4: 366 ← BH: 197. SIII: = *Thelephora* ~ Fr.

31. With 4: 288 ← BH: 442. SV: = ~ (*Hypholoma*) ~ Bull.

32. With 4: 305 ← BEF: t. 24, f. 125. SV: = ~ (*Pleurotus*)~ Batsch.

33. BH: 264.

34. No reference to BH: index (cfr. Mycotaxon 6: 157. 1977).

35. SV: = *Merulius tremellosus* Schrad.

36. SIV: = ~~ Sow.

37. BH: 192.

38. A&S xvii: 82.

39. *Nom. superfl.* ≡ *A. glutinosus* BH: 527.

40. Position doubtful. PD: 41.

41. HFA.

42. With 4: 379 ← BH: 158 ← [LSP: 1184]. SIV: = *Scleroderma vulgare* Fr.

43. BH: 320 ← With 4: 312. SII: = *Boletus versipellis* Fr.

44. With 4: 261 ← Sch: 18, *nom. superfl.* [≡ *A. filamentosus* Scop: 441]. SV: = *Hygrophorus obrusseus* Fr.

45. With 4: 340 (*Helvella*) ← Bolt: 98.2 (*Helvella*).

46. BH: index, *nom. superfl.* [≡ *A. annularius* Bull. *apud* Vent., BH: 626]. SII: = ~ (*Pholiota*) *spectabilis* Fr.

47. Sch: 115.

48. Sch: 156.

49. With. [no further citation].

50. LSpPl: 1648 ← [LSP: 1178]. SIV: = ~~ Linn.

51. BH: 303 (as "barba-jobi"). SV: = *Odontia* ~ Fr.

52. Eng. Bot. t. 701.

53. LSpPl: 1645. SIII: = *Lenzites* ~ Fr.

54. BH: 348. SIV: = *Polyporus* ~ Fr.

55. Rank uncertain but taxon new. See following.

56. Sowerby cites BH, where this name cannot be found. Whether these two inclusions of *P. bicolor* are of homonyms is unclear.

57. BH: 333. SIII: = *Polyporus rufescens* Fr.

58. Bolt: 122, non BEFC 1: 271. Introduced dubiously.

59. Sch: 98.

60. POM (as "Botritis parasiticus"). No reference to Bolt: 132 ("botrytis").

61. Sch. 94 ← [LSP: 1178].

62. GSN: 726 ← [LSP: 1183]. SV: = *Bovista plumbea* Pers.

63. Dick I: 23.

64. BH: 594.

65. PS: 139.

66. BEF: 214. S II: = ~ (*Omphalia*) *stellatus* Fr.

67. With 4: 149.

68. Authority doubtful. If HFA, then BH: 670 ← Sch. 4: 21. SIII: = *Cortinarius* (*Telamonia*) ~ Fr.

69. In footnote only.

70. Clearly as *sp. nov.,* with no reference to BH: 209.

71. Reference is to WBP: 330, which I do not know.

72. Sch: 147.

73. BH: 338.

74. SEF incorrectly cites BH: 416.3. No such name occurs in BH.

75. BH: 562, *nom. superfl.* [≡ *A. dentatus* LSP: 1172]. In SEF index as "chamaeleon".

76. WBA 3: 445.

77. LSpPl: 1641. SV: = ~ (*Psalliota*) ~ Linn.

78. Jacq. Fl. Aust. t. 17 (*Lycoperdon*).

79. BEF.

80. BEF or BEFC.

81. CFL 4: 73 ← Sch: 135.

82. BH: 297 (*Helvella*) [≡ *A. incurvus* Sch 4: 29]. S II: = *Cantharellus tubaeformis* Fr.

83. BH: 505 ← [LSP: 1171]. In SEF index as "chantarellus". SII: = *Cantharellus cibarius* Fr.

84. No reference to *Sphaerocarpus capsulifer* BH: 139. SV: = *Polysaccum olivaceum* Fr.

85. BH: 85.

86. CFL: 5. SIV: = ~ (*Collybia*) *maculatus* A. & S.

87. *Nom. superfl.* [≡ *B. flabelliformis* BEF: f. 226]. SIV: = *Polyporus adustus* Fr.

88. LSpPl: 1654.

89. SEF incorrectly cites Bolton, where no such name can be found.

90. BH: 284 ← [Sch: 115 (*Elvela*)]. SIV: = *Thelephora laciniata* Pers.

91. Dick I: 20 ← Sch: 115 (*Elvela*).

92. Mentioned with no authority.

93. BH: 545. SIII: = *Marasmius* ~ Fr.

94. FD: 1450 (*Cellularia cyathiformis*).

95. Mentioned with BH and Relh authorities.

96. SI: = ~ (*Lepiota*) ~ Sow. Doubtfully sanctioned by Fries.

97. Jacq. Misc. 15.2. SI: = *Hygrophorus* ~ Fr.

98. Mentioned with Holmskjold authority.

99. BH: index, *nom. superfl.* [≡ *P. cochleata* LSP: 1181].

100. Introduced with uncertain rank.

101. HFA: 641 ← LSpPl: 1653.

102. BH: 254.

103. BH: 99.

104. With 4: 371.

105. BH: 173.

106. Sch: 112 ← [Scop: 431].

107. This appears to be an elevation of BH: 284, BH: 280 or BH: 282.

108. BEF t. 26, f. 107.

109. TM: t. 13, Fig. 106 (*S. macula*).

110. LSpPl: 1642 ← [LSP: 1173]. SIV. = *Cortinarius* (*Dermocybe*) ~ Fr.

111. BH: 172 ("cirratum") ← HV 1: 27 (*Sphaeria*) .

112. HV: t. 6.1.

113. With 4: 347.

114. Sch 4: 111 ("clavus").

115. Without reference to BH: 171 (*Hypoxylon* ~). Other BH *Hypoxylon* taxa were transferred to *Sphaeria* in SEF.

116. BH: 171.

117. Sch 4: 72 ("clavaeformis").

118. Introduced with Linnaeus authority.

119. WBA 3: 379 ← BH: 482. SI: = ~ (*Lepiota*) ~ Bull.

120. Bolt: 100.

121. HFA: 636 ← Sch 4: 100 (*Elvela*).

122. SIII: = ~ (*Mycena*) *strobilinus* Fr. In SEF without attribution, but Fr. 1: 105 cites Wulfen as author.

123. [LSP: 1181].

124. With BH authority, but I cannot find this name there.

125. Woodw. Trans. Linn. Soc. 2: 59. SV: = *Geaster* ~ Pers.

126. Apparently a new name for *Variolaria corrugata* BH: 187, or *Hysterium nigrum* TM 8: 64.

127. Authorities as Withering (there with no authority) and Schaeffer where I can find no such name.

128. SI: = *Cortinarius (Myxacium) elatior* Fr.

129. BH: 575, *nom. superfl.* [≡ *A. purureus* Bolt: 41]. SIII: = ~ *(Leptonia) chalybaeus* Pers.

130. Position uncertain.

131. BEF: 152.

132. BH: index, pl. 393, *nom. superfl.* SIV: = ~ *sanguineus* With.

133. WBA 3: 354. SII: = *Hygrophorus ovinus* Sow.

134. SI:= *Panus cochleatus* Fr.

135. Bolt: 140, *nom. superfl.* SIV: = *Coprinus micaceus* Fr.

136. FD: 1534.

137. WBA 3: 293.

138. WBA 3: 302 ← BH: 518, *nom. superfl.* [≡ *A. lateralis* Sch 4: 31].

139. With 4: 366 ← LSpPl: 1652. In SEF index as "corralloides". S V: lower fig. = ~*rugosa* Bull.; upper fig. = ~ *coralloides* Linn.

140. With 4: 334 ← Sch: 95 ← [Scop: 472]. SIV: =~~ Scop.

141. Relh. Supple. 3: 34 ← BEF: 139. SI: = *Calocera* ~ Fr.

142. Sch 4: 107.

143. BH: index ← [LSP: 1181]. SII: = *Craterellus* ~ Fr.

144. FD: pl. 838.

145. Reported as *comb. nov.* by Sowerby, but I cannot find the basionym. SV: = ~ *mesenterica* Fr.

146. Relh: 898.

147. BH: 187.

148. BH: 475. SIV: = ~ (*Mycena*) "corticolus" Schum.

149. TM: t. 14, fig. 111.

150. Sch 4: 38. SIII: = ~ (*Collybia*) *radicatus* Relh.

151. BH: 636.

152. Sch 4: 55.

153. No reference to *Helvella crispa* BH: 293.

154. WBA 3: 319 ← Bolt 51.2, *nom. superfl.* [≡ *A. ochraceus* BH: 644].

155. BH: 553, *nom. superfl.* [≡ *A. conicus* Scop: 443].

156. Sch 4: 125 ← [Scop. 486].

157. With: 164.

158. Bolt: 66.

159. FD: 1450.

160. BH: 212, *nom. superfl.* [≡ *C. pistillaris* LSP: 1182]. SII: = ~ *fragilis* Holmsk.

161. With 4: 286 ← Sch 4: 5. SIII: = *Coprinus comatus* Fr.

162. SI: = ~ *ochraceum* Pers.

163. SII: = ~ (*Clitocybe*) ~ Sow. Sanctioned by Fries at unnamed variety rank only.

164. In SEF index as "decorticans". New name for *Hypoxylon nummularium* BH: 179. Cfr. pl. 371.3 where Sowerby states the intended name as *S. decorticans*.

165. With 4: 382. SV: = *Scleroderma verrucosum* Pers.

166. Sch 4: 7 ← [Scop: 451]. SIII: = *Lactarius* ~ Fr.

167. Introduced *in obs.* with HFA authority.

168. WBA 3: 478 ← LSpPl: 1649 (*Clathrus*).

169. With 4: 394 ← Bolt: 122, *nom. superfl.* [≡ *Variolaria punctata* BH: 185].

170. POM I: f. 4.

171. LSpPl: 1652. SI: = *Xylaria polymorpha* Grev.

172. BH: 192 (*Clavaria*) ← [LSP: 1182].

173. With 4: 289 ← BH: 470. SIII:= ~ (*Collybia*) "*dryophilus*" Bull.

174. Authority incorrectly cited as BH: pl. 224.

175. SII: = ~(*Pleurotus*) *mastrucatus* Fr.

176. Introduced with dubious rank.

177. BH: 322, *nom. superfl.* [≡ *B. bovinus* LSP: 1177]. SI : = ~ *regius* Krombholz.

178. WBA 3: 189.

179. SV: = *Stereum purpureum* Pers.

180. BH: index.

181. Bolt: 28, *nom. superfl.* [≡ *A. cinerascens* BH: 598]. SI: = *Russula nigricans* Fr.

182. SI: = ~ (*Clitocybe*) ~ Sow.

183. BH: 183 (*Variolaria*).

184. BH: 246, *nom. superfl.* [≡ *P. coccinea* Bolt: 104].

185. LSpPl: 1654 ← [LSP: 1184]. See following footnote.

186. Introduced at dubious rank and without authority, but with only doubtful connection to the preceding.

187. Dick 3: 22; With 4: 360.

188. FD: pl. 779.3.

189. FD: pl. 1329.

190. FD: pl. 779.3 (*Helvella*).

191. Willd: pl. 7, fig. 20 ← With 4: 378.

192. LSpPl: 1648 ← [LSP: 1178 (*Phallus*)]. SII: central two figs. = *Morchella semilibra* DC; other figs. = *M. esculenta* Pers.

193. BH: index.

194. HFA: 616. SIV: = ∼ (*Clitocybe*) *laccatus* Scop.

195. With 4: 366.

196. With 4: 268 ← Bolt: 29, *nom. superfl.* [≡ *A. pulverulentus* BH: 478, *nom. superfl.*; ≡ *A. amarus* BH: 478, etc., *nom. superfl.* for various Schaeffer names]. SI: = ∼ (*Hypholoma*) ∼ Huds.

197. Bolt: 97.

198. BH: 281, *nom. superfl.* [≡ *Boletus auriformis* Bolt: 82]. SI: = *Hymenochaete rubiginosa* Lev.

199. Sch 4: 85.

200. No reference to ∼∼ BH: 108, *nom. superfl.* [≡ *M. erysiphe* LSP: 1186].

201. SV: = ∼ (*Inocybe*) ∼ Sow.

202. BH: 534. S I: = ∼ (*Omphalia*) ∼ Bull.

203. BH: 130.

204. Sch 4: 48 ← [Scop: 441].

205. BH: 205, *nom. superfl.* [≡ *C. gyrans* Bolt: 112].

206. Bolt: 61.

207. LSpPl: 1643. SIII: = *Coprinus atramentarius* Fr.

208. With 4: 302 ← Sch 4: 20. SII: = *Panus stypticus* Fr.

209. BEF: fig. 226.

210. SI: = ~ (*Clitocybe*) ~ Sow.

211. With 4: 209 var. 2. SV: = ~ (*Clitocybe*) *vernicosus* Fr. Cfr. following footnote.

212. Bolt: 149 ← [Sch 4: 17]. SII: = *Bolbitius fragilis* Fr.

213. Sch 4: 83 ("flavorufus").

214. SEF index as "flavis". With 4: 320.

215. Sch 4: 27. SV: = ~ (*Pholiota*) *squarrosa* Mull.

216. Dick 3: 22 ← Sch 4: 110 (*Elvela*). SII: = *Craterellus crispus* Fr.

217. No reference to *Sphaerocarpus* ~ BH: 142.

218. Doubtful reference to Relhan as authority. SI: = *Marasmius foetidus* Fr.

219. *Nom. nov.* replacing polynomials. SV: = *Ithyphallus impudicus* Fisch.

220. LSpPl: 1645. SIII: = *Polyporus* ~ Fr.

221. HFA: 644. SIII: = *Geaster* ~ Fr.

222. With 4: 391 ← Dick: 24.

223. Dick 1: 25, With 4: 385.

224. Roth, Crypt. minus nota 7.

225. Velley *in* WBA 3: 307. SI: = ~ (*Clitocybe*) ~ Sow.

226. With 4: 393, *nom. superfl.* [≡ *S. concentrica* Bolt: 180].

227. Dick 1: 18. SII: = *Polyporus intybaceus* Fr.

228. With 4: 350 ← BH: 236, *nom. superfl.* [≡ *P. carpini* BEFC 1:217].

229. Sch 4: 113. S III: = ~ *elastica* Bull.

230. With dubious authority.

231. Although surely a homonym with *M. fulva* (q.v.), Fries treated the two differently. SEF pl. 378.8 as an *Aspergillus*, pl. 400.4 as a *Hydrophora*.

232. POM I: pl. 4, fig. 3.

233. S IV: = ~~ Sow.

234. Sch 4: 10.

235. SV: = ~ (*Naucoria*) *cucumis* Pers.

236. SV: = ~ *rugosus* Fr.

237. Bolt: 136.

238. GSN: 1473; Relh. Supple. 3: 36.

239. Sch 4: 58.

240. BH: 612, *nom. superfl.* [≡ *A. crassipes* Sch 4: 38; *A. oedematopus* Sch 4: 69].

241. Sch 4: 23 ← [Scop: 455]. SIII: = ~ (*Mycena*) *parabolicus* Fr.

242. BH: 296, *nom. superfl.* [≡ *H. lutea* Berg. I: 151].

243. BH: 546. SII: = ~ (*Inocybe*) ~ Sow.

244. LSpPl: 1642. SV: = ~ (*Psalliota*) *arvensis* Schaeff.

245. BEF: 29.

246. TM I: 136.

247. Sibth: 420. SIV: = *Paxillus* ~ Fr.

248. With 4: 206 ← Sch 4: 23. SIV: = *Cortinarius* (*Phlegmacium*) *cyanopus* Fr.

249. Authority as Persoon, with no reference.

250. With 4: 382 ← Bolt: 118.

251. CFL 3: pl. 69 ← BEF: 110. Cfr. following footnote.

252. Sch 4: 17. Homonym of BEF: 110. SI: = *Gomphidius* ~ Fr.

253. TM: pl. 16, fig. 125.

254. WBA3: 313.

255. Bolt: 111. S V: = ~~ Holmsk.

256. SIV: = *Cenococcum* *geophilum* Fr.

257. BH: 176 (*Hypoxylon*).

258. With 4: 181. SIV: = ~ (*Tricholoma*) *gambosus* Fr.

259. Position uncertain.

260. In SEF index as "helveolus". Sch 4: 48.

261. BH: 93.

262. HFA: 625. SII: = *Fistulina* ~ Fr.

263. With 4: 405 ← Sch 4: 82 (*Boletus*).

264. PCC: pl. 3, fig. 4.

265. In SEF index as "herculanea". With 4: 362. SIV: = ~ *pistillaris* Linn.

266. Bolt: 164.

267. With 4: 232. SIII: = *Cortinarius* (*Telamonia*) ~ Fr.

268. Sch 4: 124.

269. Sch 4: 108

270. Relh. Suppl. 1: 32 ← HFA: 635.

271. TM: pl. 16, fig. 125.

272. With 4: 224 ← BH: 573. SV: = ~ (*Naucoria*) ~ Bull.

273. BH: 86, *nom. superfl.* [≡ *Mucor septicus* LSpPl: 1656].

274. No reference to BH: index, pl. 398. SIV: = ~ (*Hebeloma*) *mesophaeus* Fr.

275. SV: = *Polyporus* ~ B. & Br. In SEF with no authority. Fr I: 362 as *Polyporus*, with Bosc as authority.

276. BH: 243 (*Peziza*).

277. Sch 4: 102.

278. New name for *Hypoxylon loculiferum* BH: 174.

279. LSpPl: 1652 (*Clavaria*).

280. With authority as BEF.

281. LSpPl: 1645 ← [LSP: 1176.] SIII: = *Polyporus* ~ Fr.

282. LSP: 1178. SII: = ~~ Linn.

283. BH: 349. SII: = *Polyporus giganteus* Fr.

284. No indication that these are homonyms, and both introduced with no reference.

285. With BEF as authority.

286. BEF: pl. 23, fig. 116a-c. SIII: = *Cortinarius* (*Telamonia*) *evernius* Fr.

287. With BH as authority, but I cannot find this name there.

288. LSpPl: 1648 ← [LSP: 1179].

289. SV: = *Russula foetens* Fr.

290. With 4: 349 ← Bolt: 106 ("inflecta").

291. BH: 510, *nom. superfl.* [≡ *A. fimbriatus* Bolt: 61].

292. Sch 4: 110.

293. Sch 4: 110.

294. BH: 552.

295. SV: = ~ (*Clitopilus*) ~ Sow.

296. SV: = *Polyporus amorphus* Fr.

297. LSpPl: 1640. SIII: yellow pileus = *Russula ochroleuca* Fr.; blood red pileus = *R. emetica* Fr.?; rose pileus = *R. veternosa* Fr.

298. Sch 4: 8 ← [Scop 448].

299. In SEF index as "lacrymans". Jacq. J. Misc. 2: pl. 8; Dick 1: 18 ("lacrymans") ← WJ 2: 111. SII: = ~ *lacrymans* Fr.

300. With 4: 366 ← Sch 4: 122. SIII: = *Thelephora cristata* Fr.

301. BH: 438. SI: = ~ (*Hypholoma*) *velutinus* Fr.

302. LSpPl: 1641 ← [LSP: 1172]. SIII: = *Lactarius rufus* Fr.

303. With 4: 320 (as variety?). SV: = ~ *granulatus* Linn.

304. PD: pl. 3, fig. 7.

305. BH: index. In SEF index as "lacunosum".

306. Position uncertain. No reference to *Tremella nigricans* var. *laevi* BH: 217, *nom. illeg.*

307. WBA 3: 446 ← [BH: 165, *nom. superfl.* (≡ *Peziza crucibuliformis* Scop. 486)].

308. BH: 260, *nom. superfl.* [≡ *Elvela ochracea* Sch 4: 103].

309. With HFA as authority.

310. Bolt: 83.

311. With 4: 231. SII: = ~ (*Pluteus*) *cervinus* Sch.

312. With Linnaeus ("LSp") as authority, but I can find no such name by this author.

313. As variety β. LSpPl: 1650.

314. FD: pl. 1077.

315. BH: 597.

316. Position uncertain.

317. No reference to BH: 103. Fr 3: 215 cites BH as authority.

318. Dick 4: pl. 12.

319. Sch 4: 74, *nom. superfl.* [≡ *A. lubricus* Scop. 447].

320. With 4: 158. Disowned in SEF pl. 205. SII: = *Lactarius vellereus* Fr. Cf. following footnote.

321. With 4: 158. Also with BH and Bolt as authorities, where no such name occurs. SIV: = *Lactarius plumbeus* Fr.

322. [≡ *A. infundibuliformis* BH: 510]. SIII: = ~ (*Clitocybe infundibuliformis*) Sch.

323. BH: 174.

324. BH: 613.

325. CFL 4: 72. SIII: = *Polyporus* ~ Fr.

326. Sch 4: 78.

327. BH: 87, *nom. superfl.* [≡ *Mucor septicus* Bolt 134].

328. WBA 3: 344 ← Bolt. 50 (*non* HFA: 611).

329. LSpPl: 1646 ← [LSP: 1177]. S V: = ~ *flavus* With.

330. With 4: 392 ← Wigg: pl. 3, fig. 2.

331. With 4: 386 ← BH: 95, *nom. superfl.* [≡ *Mucor lycogalus* Bolt. 133].

332. BH: 610, *nom. superfl.* [≡ *Elevela clavata* Sch 4: 100]. SV: = *Nyctalis asterophora* Fr.

333. TM: pl. 13, fig. 106.

334. Relh. Supple. 2: 29 ← FD: pl. 779, fig. 1.

335. Dick 1: 23 ← Bolt: 181 .

336. Sch 4: 130.

337. With 4: 325 ← [WJ 1: 141]. SV: = *Polyporus vaillantii* Fr.

338. Sowerby acknowledged this as a later homonym, but failed to cite the earlier authority. In SEF index as "meleagris".

339. Bolt: 141.

340. Dick 1: 21.

341. With 4: 153 ← Bolt: 177 (*Helvella*).

342. BH: 302. SV: =~~ Bull.

343. Sch 4: 91.

344. GSN: 1446 (*Tremella* ~).

345. [Bolt: 128 (*Sphaeria*)] ← LSpPl: 1652 (*Clavaria*).

346. Sch 4: 74. SIII: = *Hygrophorus pratensis* Fr.

347. HV 1790: 6, pl. 2, fig. 2.

348. With 4: 358.

349. Relh. Suppl. 3: 37.

350. No circumscription; position uncertain.

351. LSpPl: 1649 ← [LSP: 1180 (*Elvela*)].

352. Dick 1: 17 ← Sch 4: 49, *nom. superfl.* [≡ *A. lacteus* Scop: 458]. SII: = ~ (*Crepidotus*) ~ Sch.

353. SIII: = ~ (*Entoloma*) *costatus* Fr.

354. With 4: 294.

355. Sch 4: 106.

356. No circumscription; rank uncertain.

357. With 4: 391 ← Bolt: 120 (*non* RelS 2: 31).

358. BH: 79.

359. No reference to LSP, cited by Fr 3: 320.

360. PD: pl. 1.

361. SV: = ~ (*Omphalia*) ~ Sow.

362. SIII: = ~ (*Leptonia*) *incanus* Fr.

363. BH: 588. SII: = ~ (*Tricholoma*) ~ Bull.

364. With 4: 184 ← [LSP: 1172].

365. With 4: 368 ← BH: 203 ← [LSP: 1183]. SIII: = ~~ Linn.

366. No reference to BH: 238.

367. Position uncertain. Homonym of BH: 238.

368. With BH as authority, but that attribution doubtful.

369. Sch 4: 102.

370. TM 8: 64.

371. Sch 4: 60. SII: = *Hygrophorus penaerius* Fr.

372. Dick 1: 23 ← Wigg: pl. 2, fig. 14.

373. Dick 1: 21.

374. Hoffm: p. 6, fig. 3; With 4: 390.

375. Dick 1: 17 ← Jacq. Fl. Aust. 3: 48. No reference to Scop: 430. SII: = ~ (*Claudopus*) *variabilis* Pers.

376. With 3: 477 (*Clathrus*) ← LSpPl: 1649. No reference to Bolt: 93.

377. BH: 605.

378. BH: 335. SII: = *Polyporus picipes* Fr.

379. SII: = ~ (*Mycena*) *epipterygius* Scop.

380. With 4: 398 ← BH: 122.

381. BH: 335, *nom. superfl.*[≡ *Agaricus pseudo-boletus* JFA 1:26].

382. Sch 4: 32.

383. With BEF as authority.

384. SV: = *Pistillaria puberula* Berk.

385. Sch 4: 109.

386. With 4: 349.

387. BH: 567. SI: = ~ (*Clitocybe*) ~ Bull.

388. Sch 4: 126.

389. With 4: 183. SIII: = ~ (*Clitocybe*) ~ With.

390. With 4: 365 ← Sch 4: 123 ← [LSP: 1182].

391. In SEF index as "orcades". With 4: 221 ("orcades") ← [Bolt: 151 ("oreades")].

392. BH: 170.

393. BH: 170 (*Hypoxylon*).

394. CFL 3: pl. 71 ← Jacq. Misc. 104. S V: = ~ (*Pleurotus*) ~ Jacq.

395. With 4: 293 ← Sch 4: 5 ← Scop: 425 .

396. Sch 4: 112.

397. No reference to ~~ Sch 4: 22. SV: = ~ (*Inocybe*) *sindonius* Fr. Cfr. following footnote.

398. Sch 4: 22. SIII: = ~ (*Clitocybe*) *prunulus* Scop.

399. BH: index, *nom. superfl.* [≡ *A. ulmarius* BH: 582]. SII: = ~ (*Pleurotus*) *subpalmatus* Fr.

400. BH: 244 ("papillaris"), *nom. superfl.* [≡ *P. cinerea* BEFC 1: 197].

401. With 4: 342 ← BH: 279. SV: = *Merulius corium* Fr.

402. No reference to∼∼ BH: 609. SV: = *Nyctalis*∼ Fr.

403. POM 1: pl. 5, fig. 6 ← [BH: 317].

404. WBA 3: 348, var. 1.

405. BH: 250 (*P. cyathoides*).

406. Dick 4: 27.

407. BH: 161 ← [LSP: 1184].

408. BH: 365. SIV: = *Polyporus pallescens* Fr.

409. LSpPl: 1646. SIII: = *Polyporus perennis* Fr.

410. Bolt: 58 ← WBA 3: 329. SI: = *Marasmius* ∼ Fr.

411. BH: 223 (*Tremella*).

412. Dick 2: 25 ← Reichard. Schr. Berl. Gesell. 1: 315. SIV: = *typhula* ∼ Fr.

413. BH: 622.

414. BH: 214.

415. Dick 1: 24 ← Phil. Trans. 74: 473. SV: = *Batarrea* ∼ Pers.

416. "Linn. Mont. p. 721" (*Byssus*). SV: = *Corticium coeruleum* Fr.

417. "Linn. Mont. p. 721."

418. BH: 407. SIII: = *Coprinus* ∼ Fr.

419. BH: index, *nom. superfl.* [≡ *A. geotropius* BH: 521, *nom. superfl.*; ≡ *A. mollis* Bolt. 40]. SII: =∼ (*Clitocybe*) *geotropus* Bull.

420. HFA: 622. SIII: = *Marasmius hudsonii* Fr.

421. BH: 318, *nom. superfl.* [≡ *B. feruginatus* BEFC I: 179]. SI: = ~~ Bull.

422. With Jacquin as authority.

423. Lightfoot no. 1056, with doubt. Cfr. following footnote.

424. HFA: 638. No reference to preceding.

425. Sch 4: 111 ("pyxidata").

426. CFL: 200. SV: = *Coprinus* ~ Fr.

427. Sch 4: 37.

428. BH: index, *nom. superfl.* [≡ *A. fistulosus* BH: 454, *nom. superfl.*; ≡ *A. alliaceus* JFA I: 52]. SIV: = ~ (*Mycena*) ~ Bull.

429. With 4: 356.

430. BH: index, *nom. superfl.*[≡ *B. juglandis* BH: 344 ← Sch 4: 75 ("iuglandis")].

431. HFA: 616. SIV: = *Marasmius oreades* Fr.

432. Sch 4: 12 ← [Scop: 418].

433. SIII: = ~ (*Mycena*) ~ Fr.

434. No reference to BH: 148. SV: right three = ~ *excipuliforme* Scop.; bottom left group = ~ *pyriforme* Sch; second from top =~~ Linn.

435. With 4: 264 ← Sch 4: 70. SII: = *Hygrophorus* ~ Fr.

436. FD: pl. 1073.

437. With doubtful BEF authority.

438. Sch 4: 66.

439. BH: 452.

440. Sch 4: 107, *nom. superfl.* [≡ *E. cornucopioides* LSP: 1181].

441. LSpPl: 1650 ← HFA: 634 (*Peziza*). Cfr. following footnote.

442. No reference to preceding.

443. WBA 3: 356.

444. [LSpPl: 1625].

445. With 4: 152.

446. Sch 4: 39.

447. Intended as "pustula" (Cfr. pl. 375.1).

448. BH: index.

449. No reference to ~~ BH: 129.

450. With 4: 307 ← LSpPl: 1644.

451. Under plate 228 as "guercinus".

452. With Linnaeus as authority.

453. WBA 3: 335 ← RelS: 28. SI: = ~ (*Collybia*) ~ Relh.

454. Dick 4: 27.

455. Sch 4: 79 ← [Scop: 470].

456. BH: 305, *nom. superfl.* [≡ *H. coralloides* Scop: 472].

457. BH: 349.

458. Bolt: 138 ← ["Blacks. Spec. Bot. pl. 1"].

459. Woodw. Tr. Linn. Soc. 2:58; With 4: 375.

460. With Linnaeus as authority.

461. BH: 281, *nom. superfl.* [≡ *Boletus auriformis* Bolt 82]. SI: = *Stereum hirsutum* Fr.

462. BH: 311 ← [LSP: 1178].

463. Bolt: 165. SV: = *Daedalea vermicularis* Pers.

464. WBA 3: 289.

465. BH: 289.

466. Rank uncertain.

467. BH: 588. SV: = ~ (*Inocybe*) ~ Bull.

468. BEF: pl. 12, fig. 58.

469. BH: 473, *nom. superfl.* [≡ *A. ianthinus* BEF: 79].

470. BEF: pl. 12, fig. 58 (*Monilia*).

471. With Scopoli as authority. SII: = *Marasmius* ~ Fr.

472. BH: 326, *nom. superfl.* [≡ *B. olivaceus* Sch 4: 77]; With 4: 315, *nom. superfl.* [≡ *B. luridus* Sch 4: 78]. SI: = ~ *satanus* Lenz.

473. WBA 3: 209.

474. No reference to ~~ BH: 206. Cfr. following footnote.

475. No reference to preceding. SIV: = ~ *fusiformis* var. *ceranoides* Pers. Fr. I: 473 sanctions this name with BH authority.

476. No reference to former names. SV: = *Polyporus alligatus* Fr. Cfr. following footnote.

477. With 4: 321 ← BEF: pl. 225. No reference to preceding.

478. Sch 4: 24. SII: = *Gomphidius viscidus* Fr.

479. BH: 340. SIV: = *Trametes odora* Fr.

480. With 4: 390 ← Bolt: 121.1.

481. Jacq. Misc. 2: pl. 15, fig. 3. SI: = *Cortinarius* (*Dermocybe*) ~ Fr.

482. WBA 3: 161.

483. FD: pl. 832. SI: = ~ (*Inocybe*) ~ Mull.

484. BH: 319, *nom. superfl.* [≡ *B. rufus* Sch 4: 75]. SIII: = ~ *badius* Fr.

485. Sch 4: 55 ← [Scop. 450].

486. WBA 3: 442 ← Sch 4: 101 (*Elvella*).

487. Spelling of genus name as in SEF. Surely a *lapsus* for *Reticularia*.

488. SIII: = ~ (*Tricholoma*) ~ Sow.

489. As synonym on p. 189. With 4: 270. Fries 1: 292 as unnamed var.

490. With 4: 296. SIII: = ~ (*Panaeolus*) *separatus* Linn.

491. Sch 4: 92.

492. Lightfoot Fl. Scot. no. 1030.

493. BH: 125, *nom. superfl.* [≢ *Trichia rufa* HV 2: 10].

494. With Linnaeus as authority.

495. Sch 4: 125.

496. BH: 576.

497. BH: 383, *nom. superfl.* [≡ *A. niveus* JFA 3: 48].

498. BH: 132.

499. SEF: no. 272.

500. BH: 94.

501. With 4: 372.

502. SV: = ~ *edulis* Bull.

503. Lower figure of pl. 357 only.

504. Dick I: 16. SV: = ~ (*Clitocybe*) *cyathiformis* Fr.

505. Sch 4: 129.

506. Dick I: 21 ← FD: pl. 658.

507. SI: = *Spathularia flavida* Pers.

508. RelS I: 31 (*Clathrus*).

509. RelS I: 31.

510. With Lightfoot, *Flora Scotica* as authority.

511. BH: 166 (*Hypoxylon*).

512. SIV: = ~ (*Collybia*) *tenacellus* Pers.

513. With 4: 334.

514. With Lightfoot as authority.

515. SIV: = Polyporus ~ Fr.

516. BH: 625, *nom. superfl.* [≡ *A. floccosus* Sch 4: 27; *A. pilosus* Sch 4: 34].

517. With 4: 323 ← Bolt: 77 (*non* HFA: 626). SIV: = *Polyporus* ~ Fr.

518. BEF: pl. 84. SII: = *Marasmius epiphyllus* Fr.

519. With 4: 151.

520. With 4: 374 ← [BH: 160 ← LSP: 1184]. Cfr. following footnote.

521. Sch 4: 126 ← [LSP: 1184]. Sowerby apparently did not consider these names as contaxic but nomenclaturally the epithets trace to the same sources and are typonyms.

522. BH: 256.

523. BH: 398, *nom. superfl.* [≡ various species of *Coprinus*]. SIV: = *Coprinus nivens* Fr.

524. POM: pl. 4, fig. 5 (*Ascobolus furfuraceus*).

525. WBA 3: 436 ← HFA: 636.

526. With 4: 191. SII: = ~ (*Armillaria*) *melleus* Vahl.

527. No reference to Bolt: 102.

528. WBA 3: 446 ← [BH: 166 ← LSP: 1180 (*Peziza lentifera*)].

529. BH: 433, *nom. superfl.* [≡ *A. plicatus* Sch 4: 15]. SIII: = ~ (*Psathyrella*) *disseminatus* Fr.

530. BH: 389, *nom. superfl.* [≡ *A. semipetiolatus* Sch 4: 47].

531. LSpPl: 1646 ← [LSP: 1177]. SIV: = *Trametes* ~ Fr.

532. Rank uncertain. SV: = *Cantharellus aurantiacus* Fr.

533. LSpPl: 1645. SV: = *Polyporus cytisinus* Berk.

534. BH: 306. SII: = *Sistotrema confluens* Pers.

535. SIV: = ~ (*Inocybe*) ~ Fr.

536. WBA 3: 205.

537. Bolt: 124.

538. BH: 563. SI: = ~ (*Tricholoma*) ~ Bull.

539. BH: 347. SIII: = *Polyporus* ~ Fr.

540. WBA 3: 433 (*A. nicotiana*) ← Bolt: 174 (*Helvella*). SI: = *Hymenochaete* ~ Lev.

541. WBA 3: 359 ← Sch 4: 31. SI: = ~ (*Galera*) ~ Sch.

542. BEF: 183.

543. BH: 447.

544. With BH as authority, but I find no such name there.

545. WBA 3: 311 ← Sch 4: 28. SII: = ~ (*Tricholoma*) ~ Sch.

546. BH: 508, *nom. superfl.* [≡ *A. atro-squamosus* BEF: 81.] SII: = "Lenticus" ~ Fr.

547. BH: 417. SIII: = *Bolbitius* ~ Fr.

548. BH: 402.

549. Sch 4: 7. SII: = *Lactarius* ~ Fr.

550. Rank uncertain.

551. BH: 278.

552. With 4: 344 (*Auricularia*) ← Bolt: 172 (*Helvella mesenterica*).

553. With 4: 391.

554. Sch 4: 53. SIV: = ~ (*Pleurotus*) ~ Sch.

555. Bolt: 38.

556. Bolt: 127.2.

557. Sch 4: 65. SV: = *Lentinus lepideus* Fr.

558. Sch 4: 104, *nom. superfl.* [≡ *E. lubrica* Scop: 477].

559. With 4: 393.

560. SIII: = ∼∼ Sow.

561. BH: 266.

562. HFA: 632.

563. With 4: 400 ← Bolt: 94.3 (*Clathrus*).

564. BH: 645, *nom. superfl.* [≡ *A. sericeus* Sch 4: 12]. SII: = *Cortinarius* (*Phlegmacium*) *multiformis* Fr.

565. Bolt: 94.3.

566. SIV: = *Xerotus degener* Fr.

567. Rank uncertain.

568. BH: 582. SII: = ~ (Pleurotus) ~ Bull. Cfr. following footnote

569. Rank uncertain. No reference to preceding.

570. SII: = *Polyporus* ~ Fr.

571. NBA 3: 162.

572. WBA 3: 289.

573. PD: 73.

574. Sch 4: 88.

575. BH: 365.

576. With 4: 401 ← Dick 1: 25.

577. BH: 577, *nom. superfl.* [≡ *A. senescens* BEFC 2: 35].

578. BH: 176, *nom. superfl.* [≡ *Sphaeria deusta* HV 1: 3].

579. BH: 153.

580. Sch 4: 13.

581. BH: 664, *nom. superfl.* [≡ *A. plumbeus* Sch 4: 37].

582. Sch 4: 88 (*B. versicolor*) ← [LSP: 1176].

583. With 4: 240.

584. WBA 3: 290.

585. With 4: 331. SV: = *Polyporus hispidus* Fr.

586. Rank uncertain. SV: = ~ (*Collybia*) ~ Curt.

587. CFL 4: 70. SV: = ~ (*Collybia*) ~ Curt.

588. Lightfoot no. 1057 ← [Scop: 483]. SIV: = ~ *fragilis* Holmsk.

589. Incorrect authority; Bolt. 47.

590. Sch 4: 88 ← [LSP: 1176.]

591. BH: 270, *nom. superfl.* [≡ *P. cochleata* LSP: 1181].

592. Incorrect authority; [SIN 3: 1923.]

593. BH: index, *nom. superfl.* [≡ *A. contiguus* BH: 518, *nom. superfl.*; ≡ *A. lateralis* Sch 4: 31].

594. With 4: 207 [LSP: 1173]. SIV: = ~ (*Tricholoma*) *personatus* Fr.

595. WJ 2: 104. SI: = *Hygrophorus* ~ Fr.

596. WBA: 320 ← [Scop: 437, as "virens"].

597. New name for *A. glutinosus* CFL 3: 69 and *A. semiglobatus* With 4: 270. SV: = ~ (*Togaria*) *praecox* Pers.

598. BH: 663, *nom. superfl.* [≡ *A. pulvinatus* Bolt: 49]. S : = ~ (*Volvaria*) ~ Bull.

599. SV: = *Lentinus* ~ Fr.

600. WBA 3: 331. SI: ~ (*Tricholoma*) *rutilans* Sch.

601. With 4: 193 ← BH: 491, *nom. superfl.* [≡ *A. fuscus* Sch 4: 58]. SIII: = *Lactarius circellatus* Fr.

602. BH: 642, as "xylophilus". SIII: = ~(*Psathyrella*) *noli-tangere* Fr.

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GAUTHIEROMYCES, A NEW GENUS OF HARPELLALES BASED ON GENISTELLA MICROSPORA

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In 1960 Gauthier described a new and rare species of Trichomycetes, *Genistella microspora* (nom. nud.), but she did not furnish a Latin diagnosis or cite a nomenclatural type. Furthermore, the species is certainly not assignable to the genus *Genistella* Léger & Gauthier (now *Legeriomyces* Pouzar, 1972), because of *G. microspora*'s distinctively different trichospore and thallus morphology. Gauthier discovered the fungus in nymphs of the mayfly species *Baetis pumilus* (Burm) living in streams (Bresson, Tavernolles) located near Grenoble, France. The insect hindguts also contained *Legeriomyces ramosus* (Léger & Gauthier) Pouzar. I attempted to rediscover and study Gauthier's species from streams near Grenoble, and although *L. ramosus* was relatively abundant in Baetidae nymphs, *G. microspora* was not present. Nevertheless, the species is so distinctive that it deserves proper nomenclatural treatment. The diagnoses which follow and the holotype are based on Gauthier's 1960 publication.

GAUTHIEROMYCES Lichtwardt, gen. nov.

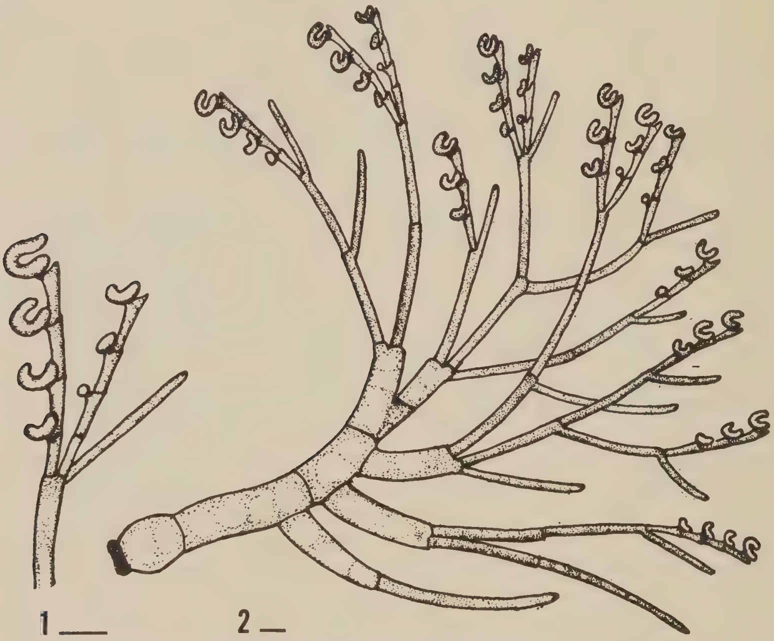
Thallus arbusculiformis, trichosporas forma soleae equorum ferreae basi-lateraliter affixas ad cellulas generativas producens. Proctodaei nympharum Baetidarum incolae.

Type species: *Gauthieromyces microsporus* Lichtwardt.

Gauthieromyces microsporus Lichtwardt, sp. nov.

Thallus arbusculiformis usque ad 300 µm longus, axe principi et rami primarii crassis (15-20 µm diametro), secondariis angustioribus (3-6 µm diametro), retinaculo conspicuo praeditus. Trichosporae forma soleae equorum ferreae, totae 10-12 x 9 µm, juxta basim lateraliter affixae, ramo fertili quoque ad 4 gignente. Trichosporarum appendiculae atque zygosporae ignotae. Nympharum *Baetis pumili* (Burm) Baetidarum Ephemerapterorum cuticulae proctodaei incola.

Holotype: Figs. 1, 2 in Gauthier, 1960, p. 226; reproduced as Figs. 1, 2 herein.



Figs. 1, 2. Holotype of *Gauthieromyces microsporus* based on Gauthier's 1960 drawings of *Genistella microspora* (nom. nud.). Bars = 10 µm.

Trichospores of the genus *Legeriomyces (Genistella)*, to which *Gauthieromyces microsporus* was first assigned, are obpyriform and bear two long and obvious appendages. The only Legeriomycetaceae having curved spores, other than *G. microsporus*, is *Orphella coronata* Léger & Gauthier (1931). In that species, like *G. microsporus*, the number of appendages, if any, is not known. However, the reproductive branches in these two species are quite different: *G. microsporus* produces typical harpellid basipetal series of generative cells on terminal branches, whereas the trichospores of *O. coronata* are borne in an unusual cymose arrangement of branches and the generative cells are produced subterminally and singly on two-celled terminal branches.

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AN AGGREGATION OF EMBELLISIA SPECIES

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SUMMARY

A keyed and illustrated presentation of all (13) known species of *Embellisia* Simmons: 4 already published, *E. allii*, *E. chlamydospora*, *E. didymospora*, *E. hyacinthi*; 1 comb. nov., *E. phragmospora*; and 8 spp. nov., *E. abundans*, *E. conoidea*, *E. indefessa*, *E. oxalidicola*, *E. planifunda*, *E. telluster*, *E. tumida*, and *E. verruculosa*.

Embellisia Simmons is the name of a genus whose time surely had arrived when it was segregated from somewhat similar genera with phaeophragmo-/phaeodictyoconidia (Simmons 1971). As early as 1938, E. W. Mason had examined a puzzling isolate from barley, sent to CMI from Cyprus by R. M. Nattrass; comparison with some small-spored species of "*Helminthosporium*" and "*Curvularia*" led Mr. Mason to conclude that it was impossible to assign a name to the Nattrass specimen (E. W. Mason notes in Herb. IMI dtd 17/3/38). The fungus is, in fact, an example of what now is called *Embellisia chlamydospora* (Hoes et al.) Simmons, a species known mostly from soil and rhizosphere isolates. Some sporulation characters of the species, as Mr. Mason observed, did not fit acceptably in any established genus of the time.

Additionally, an extremely common inhabitant of garlic bulb scales, *E. allii* (Campanile) Simmons, the type species of the genus, had had a comfortable home in *Helminthosporium* for 25 years before the Hyphomycete classification upheavals of the 1950's and 1960's (see Simmons 1971 for related introductory and historical notes). Such residence became untenable, however, when the pattern of conidium development and mature morphology now held for *Embellisia* was compared with generic patterns of typical *Helminthosporium*, *Drechslera*, *Bipolaris*, *Alternaria*, and *Ulocladium*.

Typical *E. allii* and *E. chlamydospora* sporulation exhibits straight to repeatedly geniculate conidiophores and dematiaceous conidia that may be straight or variously curved, enlarged near the base or near the apex, and phragmoseptate or becoming sparingly dictyoseptate. The range of conidium character variation has made generic circumscription difficult; this diversity has contributed to defensible but predictably unpopular conclusions such as that repetitive sporulation in chains does not necessarily define an *Alternaria* species within this generic group of moulds, that pronounced curvature of conidia does not of itself define a *Curvularia* — or that a unit character of obovoid conidium does not alone signify a *Ulocladium* any more than that a similar but ovoid conidium can only be of an *Alternaria*.

A collection of 50-60 living isolates and specimens of similar generic misfits has accumulated in my hands over the past 10 years, about half readily assignable to *E. allii*, *E. chlamydospora*, *E. hyacinthi* de Hoog & Muller (1973) and *E. didymospora* Muntanjola-Cvetković (1976), and the other half showing combinations of culture and sporulation characters foreign to or difficult to accept in any of the old, established, catchall genera mentioned above. My purpose at present is to refine the circumscription of *Embellisia* as a genus and to describe most of the novel species that are represented in the material that has been shared with me so generously by so many individuals.

Genus Characterization

Colonies of isolates on commonly used media (PCA, Hay decoction, V-8 juice agars; see Stevens 1974) are similar in some respects to those of representative *Alternaria* and *Ulocladium* isolates: color is some shade of grey, growth is at a moderate rate at moderate temperatures, sporulation may be extremely profuse or sparse. *Embellisia* colonies usually do not produce abundant non-sporulating aerial mycelium on the media indicated, differing in this from most *Alternaria* isolates but resembling most *Ulocladium* strains.

Mycelium (in culture) may exhibit some features that are diagnostically helpful, even if they are not unique to *Embellisia*. Hyphal coils, sometimes bearing several geniculate conidiophores, are found commonly in *E. chlamydospora*; similar hyphal coils occur in *E. didymospora* and sometimes in other species described below. Intrahyphal or terminal, proliferating chlamydospores are a dominant feature of *E. chlamydospora* and some other species; clumps, chains, and other proliferating configurations of dark, thick-walled cells are found in several species. Hyphal septa often become so thick and dark that they stand out in striking contrast to the paler color of adjacent hyphal walls.

Conidiophores may be simple 1- and 2-celled hyphal branches, or they may be progressively multigeniculate aerial structures forming a sparse to dense turf over the substrate surface.

Conidia arise singly in a very small area (1-2μm diam) of conidiophore tip. The base of the young conidium is a narrow isthmus that serves as the connective between conidium and conidiophore (see Hoes et al., 1965, Figs. 2 & 3; Muntanjola-Cvetković and Ristanović, 1976, Fig. 1E). The base of the young conidium develops a hipped contour near or at the surface of its conidiophore, soon obscuring the connective peg. After a conidium secedes, the generative area of the conidiophore tip appears as a dark circle (pigment or very faint scar line) surrounding a slightly sunken area centered on the remains of the conidium isthmus. The precise fate of the conidium end of the isthmus is obscured by the thickened and slightly darkened basal wall of the conidium. Conidioid elements (aleuriospores) frequently are found in cultures of some species, e. g., *E. telluster* (sp. nov. below). These conidioid elements are hyphal tips that duplicate conidia precisely in shape, size, septation, and color but that are produced as broad-based holoblastic enlargements of conidiophore branches.

Secondary sporulation occurs in many species of *Embellisia*. This phenomenon of "chain formation" is precisely the same as that found in *Alternaria*, *Ulocladium* (e. g., *U. chartarum* (Pr.) Simmons), *Stemphylium* (rarely), *Drechslera* (e. g., *D. graminea* (Rabenh.) Shoemaker), and *Curvularia* (e. g., *C. tritici* Kumar & Nema), in that a conidium cell germinates and produces a structure that is morphologically and functionally a conidiophore. Such a secondary conidiophore in *Embellisia* can be produced from any conidium cell; in some species (e. g., *E. allii*) it very frequently is from the basal cell immediately adjacent to the basal pore. Sometimes the apical cell of an *Embellisia* conidium simply gives rise to an additional conidium without showing any sort of morphological or color change, as in *E. abundans* (sp. nov. below), in which this phenomenon of secondary sporulation without interposition of a morphologically distinctive conidiophore can account for about 50% of the secondary conidium population.

Conidium shape is extremely diverse: ovoid, obovoid, ellipsoid, obclavoid, subcylindric, straight, curved, sigmoid, or branched; septation is predominantly transverse, sometimes oblique or sparingly longitudinal; color is a shade or dilution of golden, reddish, or olivaceous brown;

ornamentation is lacking or inconspicuous in most species, but conspicuous and characteristic in *E. verruculosa* (sp. nov. below), sparse in *E. phragmospora* (comb. nov. below).

The comparatively thick and dark conidium septum remains the best clue to differentiation of *Embellisia* from similar genera. The fully developed transverse septum is composed of a very thin primary septum that joins the exosporium and that is sandwiched between thick, densely pigmented secondary layers that do not extend to the outside wall. These septa are conspicuous, subrigid discs supporting the paler, more elastic outer wall of the conidium. Septa of *Alternaria* and *Ulocladium* conidia frequently thicken and darken also, but the septum features in these two genera are duplicated in the layers of the conidium outer wall and continuous with them.

A population of *Embellisia* conidia, as is true also in many species of *Alternaria*, *Ulocladium*, and *Stemphylium*, frequently reveals two distinct patterns of conidium septation and enlargement. If a young transversely 1-2-septate conidium produces a longitudinal septum early in its development, it may enlarge laterally and remain basically broadly ovoid and comparatively short into maturity. If, however, the young conidium fails to produce a longitudinal septum, it tends to elongate without broadening significantly and then matures in a generally long ellipsoid or long obclavoid/clavoid shape (see *E. abundans* below). Average or maximum size values derived from a mixed population of such a species are only misleading. In descriptions presented here, such dual patterns of conidium development are indicated when observed, and related size and septation values are presented separately. In addition, degree of septation is noted for high but common ranges of fully developed conidia; values for extreme and uncommon examples in a population are noted in parenthesis. Conidium dimensions are given for the septation ranges cited.

Most isolates and field specimens of *Embellisia* seen thus far have come from soils, rhizospheres (wheat, carrot), plant parts in contact with soil (garlic, hyacinth bulbs; strawberry stolons), and dung. Others are from seed (wheat, barley, *Dianthus*), above-ground plant parts (*Oxalis*, *Linum*, *Alstroemeria*), natural latex, air, sea water, and nasal mucosa (horse). Geographic range of the genus is wide, including north and south temperate regions as well as wet (Java) and dry (Egypt) tropics, arid (Sahara) and flooded (Kuwait marsh, Netherlands polder) soils, and even soil from Antarctica.

Key to Species*

1. Secondary sporulation present (may be sparse) . . . . 2.
   Secondary sporulation not found . . . . 10.

2. Conidia mostly subsphaeroid, 1-septate. . *E. didymospora*
   Conidia mostly elongate, multiseptate . . . . 3.

3. Conidia conspicuously ornamented. . . . . *E. verruculosa*
   Conidia smooth or inconspicuously rough . . . . 4.

4. Secondary sporulation abundant/conspicuous. . . . . . 5.
   Secondary sporulation sparse/inconspicuous. . . . . . 8.

5. Chlamydosporic clumps abundant. . . . . *E. phragmospora*
   Chlamydosporic clumps scarce or lacking . . . . 6.

6. Conidium size mostly ca. 20 x 8µm . . . . . . *E. indefessa*
   Conidium size commonly ranging to 30-50 x 9-12µm. . . 7.

7. Longest conidia obclavoid,
   40-50 x 10-12µm . . . . *E. abundans*
   Longest conidia ellipsoid,
   32-36(-45) x 9-10µm . . . . *E. hyacinthi*

8. Conidia becoming ovoid, broad flat base . *E. planifunda*
   Conidia becoming long ellipsoid . . . . 9.

9. Conidia reaching 30-40(-56) x 10-12(-17)µm. . . *E. allii*
   Conidia mostly narrower, 25-40 x 8-10µm . . *E. telluster*

10. Conidia ovoid or conoid in maturity . . . . 11.
    Conidia elongate/subcylindroid in maturity. . . . . 12.

11. Conidia 2-transeptate, conoid . . . . *E. conoidea*
    Conidia 3-4-transeptate, ovoid. . . . . . . *E. oxalidicola*

12. Conidia broadly ellipsoid, longisepta many. . *E. tumida*
    Conidia long ellipsoid/subcylindroid,
    longisepta rare . . . . *E. chlamydospora*

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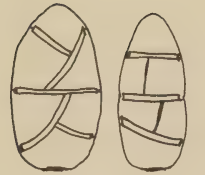
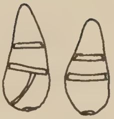
*The Key is based on characters observed for isolates grown on PCA (ca 22°C, 6/18 hr fluorescent light/dark cycle) for ca. 1 wk. Exceptions are *E. conoidea*, *E. oxalidicola*, and *E. verruculosa*, known to me only from dried specimens.

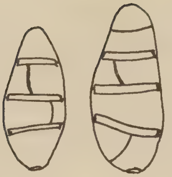
Fig. 1 (facing page). Representative *Embellisia* conidia, all at same magnification, for use as a visual aid to Key. Conidia illustrated are characteristic, even species-diagnostic in some cases. However, they do not necessarily represent maximum or average size, range of mature shape and septation, or other species-defining quality.



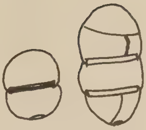
E. planifunda



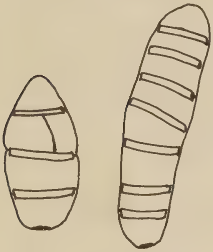
E. conoidea



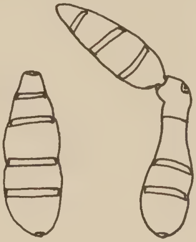
E. oxalidicola



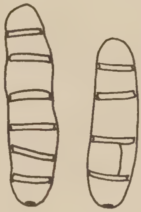
E. didymospora



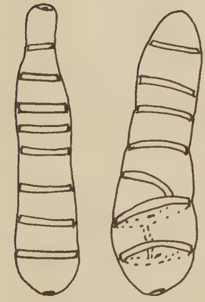
E. hyacinthi



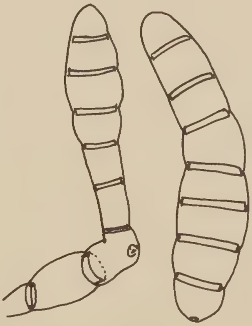
E. indefessa



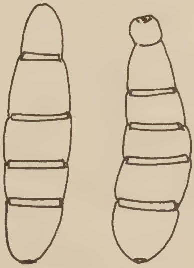
E. chlamydospora



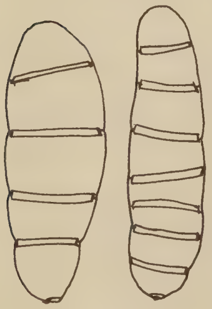
E. abundans



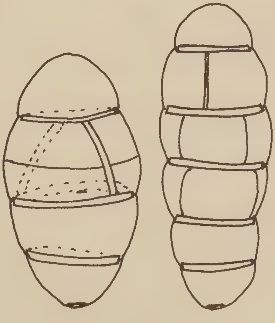
E. telluster



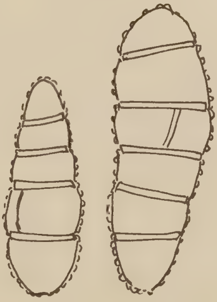
E. phragmospora



E. allii



E. tumida



E. verruculosa

EMBELLISIA ABUNDANS Simmons, *sp. nov.* Fig. 2, 15

Ex culturis in agaris PCA et V-8 descripta. Mycelium conidiophoricum arachnoideum, superficiale, copiose conidiogenum. Chlamydosporae insolitae, inchoatae; spirae hypharum rarae. Conidiophora nunc simplicia, 1-2-cellularia, nunc producta ramosa, 3-4-geniculata. Sporulatio primaria plerumque abundissima, interdum comparate sparsa; sporulatio secondaria primariam aequans. Conidia ovoidea (20-30 x 10-12µm) vel obclavoidea (40-50 x 8-12µm), recta vel parum inaequilatera, raro sigmoidea, septis transversalibus 3-6 (-8) et longitudinalibus 0(-1-2), aureobrunnea, plerumque levia vel minute aspera. TYPUS: partes ex Simmons 29-159 (LEV 4043, leg. I. C. Harvey ex stolone Fragariae, Levin, New Zealand, 1970) desiccatae et in BPI (holotypus) et pro isotypis saltem in IMI et NY conservandae.

Conidiophoric mycelium mostly arachnoid on surface of substrate, with very abundant, heavily conidiogenous, erect branches that do not, however, form a dense turf. Chlamydosporic clumps of cells scarce, and those seen are simply 4-5 conidium cells overdeveloped into a knot of 6-8 cells; hyphal coils present but not common. Conidiophores simple 1-2-celled hyphal branches, or becoming elongate, branched, geniculate at 3-4 conidiogenic loci. Primary sporulation very abundant or comparatively sparse (depending on strain); secondary sporulation characteristically about as abundant as primary.

Conidia short to long ovoid or obclavoid; straight or often slightly inequilateral, rarely sigmoid; 3-6(-8) transverse and 0(-1-2) longitudinal septa; short ovoid conidia 20-30 x 10-12µm, long ovoid and obclavoid commonly 40-50 x 8-12µm; medium golden brown with darker septa; surface usually smooth, but sometimes largest conidia minutely rough overall and frequently basal cell of small conidia with ornamented walls. Secondary sporulation often occurs by means of a conidium apex becoming converted into a 1-celled or even 2-3-geniculate conidiophore; but equally often the distal cell of a primary conidium simply gives rise to a new conidium without going through any sort of morphological or color change into a differentiated secondary conidiophore.

Representative isolates include EGS 29-159 (LEV 4043, leg. I. C. Harvey, ex strawberry stolon, Levin, New Zealand, 1970); EGS 34-063 (IMI 257339, ex *Dianthus deltoides* seed, U. K., 1981); EGS 36-008 (LEV 19729, leg. G. Laundon, ex *Hordeum vulgare* seed, Palmerston North, New Zealand, 1982).

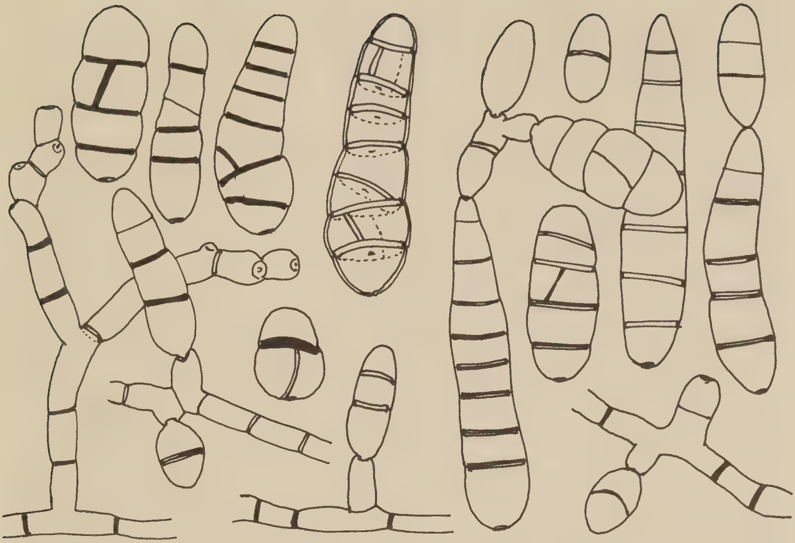


Fig. 2. Embellisia abundans, EGS 29-159, from PCA (Type).
Magn. as Fig. 3: full line = 50μm.

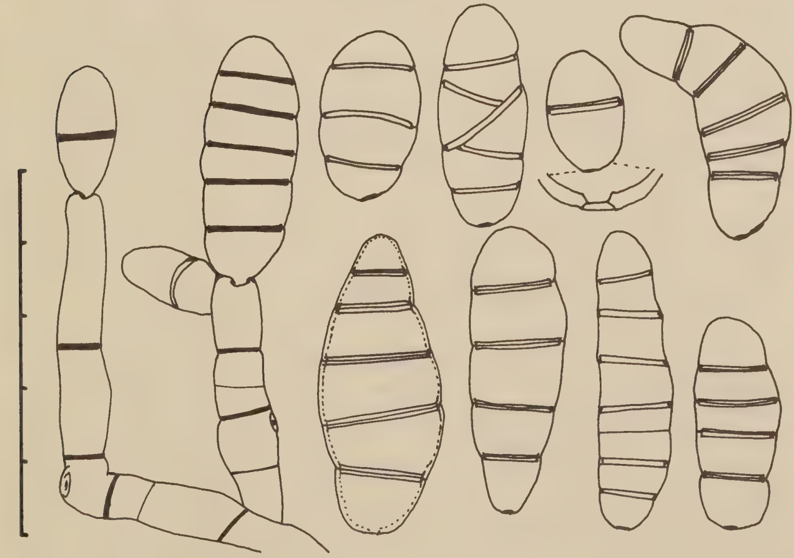


Fig. 3. Embellisia allii, EGS 19-014, from PCA culture.
Magn.: full line = 50μm.

EMBELLISIA ALLII (Campanile) Simmons Fig. 3, 16
Mycologia 63: 382. 1971.
≡ *Helminthosporium allii* Campanile
Nuovi Annali dell'Agricoltura 4(1): 103. 1924.

Individual or several adjacent hyphal cells enlarge, divide, and develop thick-walled knots and palisades of chlamydospores along with abundant conidia in specimens in nature; isolates retain high sporulation capacity in serial culture but sometimes fail to produce significant numbers of chlamydospores. Conidiophores stout, becoming progressively geniculate at conidiogenic loci, convoluted, branched, with conspicuous umbilici. Primary sporulation abundant; secondary sporulation common but not in conspicuous proportions. Typical conidiophores and conidia often produced in clumps submerged in agar substrate. Broad-based holoblastic conidioid elements common.

Conidia short to long ellipsoid or subcylindroid; straight, curved, sigmoid, or Y-shaped; 4-6(-10) transverse and 0 or uncommonly 1-2 longitudinal or oblique septa; 30-40(-56) x 10-12(-17)µm; pale/medium golden brown with dark septa; essentially smooth to slightly rough.

Collections of *E. allii* are abundant among holdings of BPI and IMI, representing numerous countries worldwide where *Allium sativum* is grown (see Simmons 1971 for material known through 1970). Representative strains include EGS 19-014 and 19-092 (E. G. Simmons, ex market garlic, production source unknown, 1966 and 1970) and EGS 33-188 (E. G. Simmons, ex local market garden, Hadley, Massachusetts, 1980).

EMBELLISIA CHLAMYDOSPORA (Hoes et al.) Simmons Fig.4,17-18
Mycologia 63: 384. 1971.
≡ *Pseudostemphylium chlamydosporum* Hoes, Bruehl & C.G.Shaw
Mycologia 57: 904. 1965.

Lateral clumps of chlamydosporic hyphal enlargements conspicuous on and in culture substrate; isolates tend to become poorly sporulating or even aconidial in serial transfers while retaining ability to produce distinctive chlamydospores. Conidiophores simple or rarely branched, septate, straight or geniculate at as many as 3-7 successively conidiogenic loci; arising from simple hyphae, from conspicuous hyphal coils on or in the substrate, or from chlamydospore cells. Primary sporulation seldom abundant; secondary sporulation not observed.

Conidia ovoid, long ellipsoid, or subcylindroid;

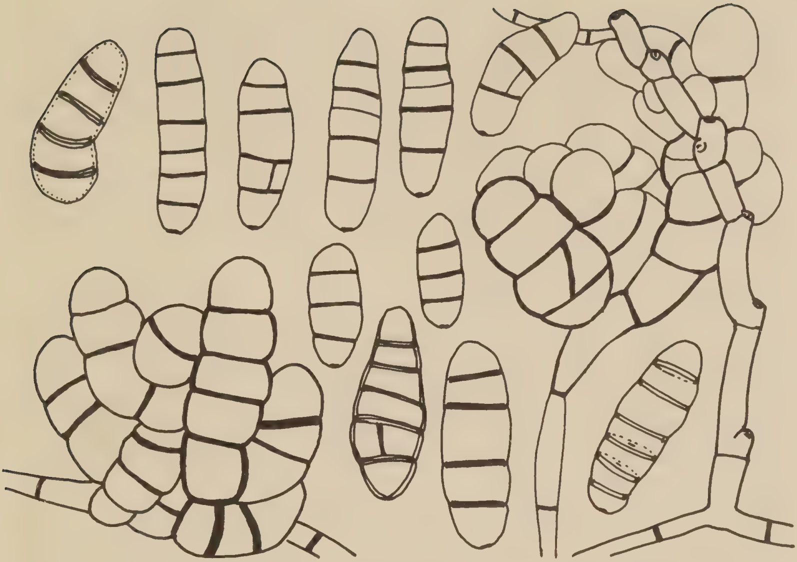


Fig. 4. Embellisia chlamydospora, EGS 10-073, from PCA. Magn. as Fig. 5: full line = 50µm.

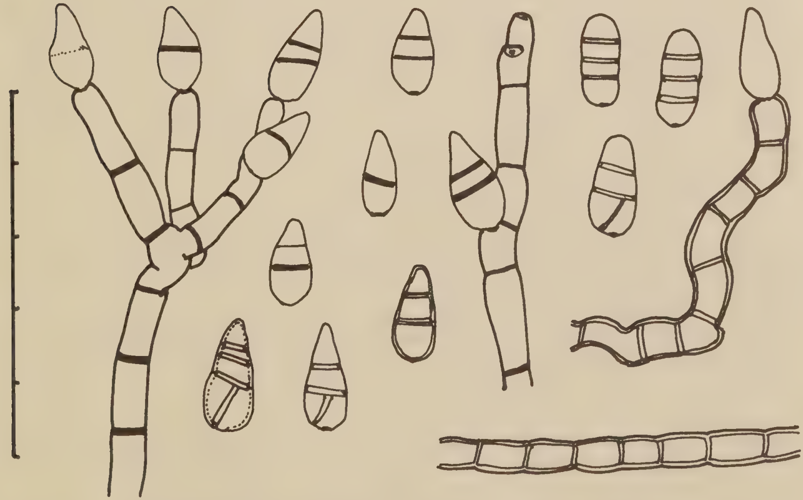


Fig. 5. Embellisia conoidea, EGS 29-179, ex Type specimen. Magn.: full line = 50µm.

straight or with minor curvature; 4-6 transverse and 0 or sometimes 1 in 1 (rarely 2) primary transverse cells; 20-30 x 7.5-9.0μm; pale golden brown with darker tones in septa; surface essentially smooth.

Sources of isolates of *E. chlamydospora* known through 1970 are listed in Simmons 1971. Representative strains include EGS 10-073 (C. T. Rogerson, ex air, Kansas, 1957); EGS 13-129 (DAOM 49987, ex *Linum*, Saskatchewan, 1956); EGS 17-132 (J. Nicot, ex soil, Sahara, 1956 [= CMI 67737]).

EMBELLISIA CONOIDEA Simmons, *sp. nov.* Fig. 5, 19

Colonia naturalis ex caespite denso, fragili conidiophororum constans. Hyphae in substrato atrobrunneae, crassiparietibus, septatae, ca. 5μm diam. Conidiophora simplicia vel ramosa, 2-4 geniculata, brunnea, ca. 200 x 5μm. Chlamydosporae et sporulatio secondario indeprensae. Conidia plerumque conoidea vel ovoidea apice acuto, raro oblonga, septis transversalibus 1-2(-3) et longitudinalibus 0(-1), 13-15 x 5-7μm, aureobrunnea, plerumque levia. TYPUS: partes ex Simmons 29-179 (leg. E. G. Simmons, in latice vetere Heveae cultae, Java, Indonesia, II-1969) in BPI (holotypus) et pro isotypis saltem in IMI conservandae.

Known only from natural growth on latex drying on wounded trunk of *Hevea sp.* Colony essentially a dense brittle turf of erect or ascending, clumped or subsynnematous conidiophores. Non-sporulating hyphal elements on substrate black-brown, thick-walled, septate, ca. 5μm diam. Conidiophores simple or becoming branched (sometimes with as many as 3-4 branches forming an apical tuft), geniculate to contorted at 2-4 conidiogenic loci, brown, commonly ca. 200 x 5μm. Distinctive chlamydosporic elements not seen. No evidence of secondary sporulation.

Conidia mostly conoid or ovoid with acute apex, less commonly simply oblong; 1-2(-3) transverse septa and 0 or sometimes 1 longitudinal or oblique septum in basal cell; 13-15 x 5-7μm; medium golden brown; surface smooth or with minor roughness.

A single collection, EGS 29-179 (E. G. Simmons, on old crustose, scarcely plastic natural latex of cultivated *Hevea sp.*, Java, Indonesia, Feb. 1969).

EMBELLISIA DIDYMOSPORA Munt.-Cvet., in Muntanjola-Cvetković & Ristanović, Mycologia 68: 49. 1976. Fig.6,20

== *Ulocladium microsporum* Moubasher & Abdel-Hafez Trans. Brit. Mycol. Soc. 69: 164. 1977.

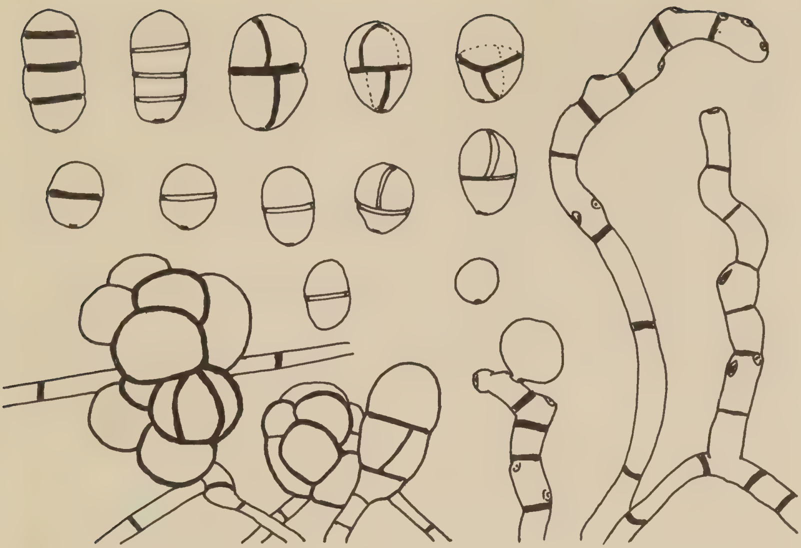


Fig. 6. Embellisia didymospora, EGS 33-108, from Hay agar (Type). Magn. as Fig. 7: full line = 50μm.

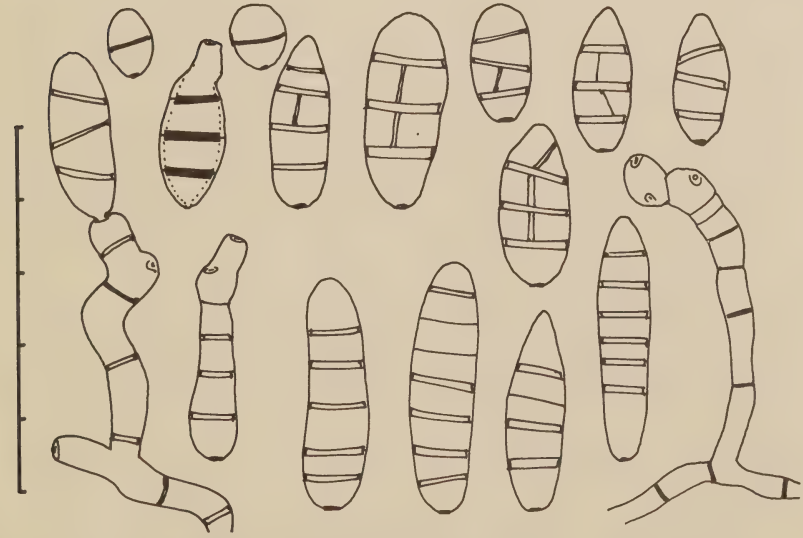


Fig. 7. Embellisia hyacinthi, EGS 19-102, from PCA (Type). Magn.: full line = 50μm.

Chlamydospores abundant as intercalary or terminal, solitary, swollen, thick-walled, dark cells, or developing as helicoid clumps of such cells. Conidiophores simple or usually becoming elongate, branched, geniculate at as many as 8-10 conidiogenic loci. Primary sporulation abundant; secondary sporulation inconspicuous but not rare.

Conidia sphaeroid to short ovoid or obovoid; 1(-3) transverse and 0-2 longitudinal septa; 10-12(-17) x 8-10µm; medium golden brown with septa simply a deeper tone of same color; essentially smooth.

Sources of specimens and isolates include sea water, soil, and equine nasal mucosa. Representative isolates include EGS 33-108 (CMI 187601 ex Type, ex Adriatic sea water, 1972); EGS 33-121 (CMI 204243, ex Type *Ulocladium microsporum*, ex soil, Egypt, 1976).

EMBELLISIA HYACINTHI de Hoog & Muller Fig. 7, 21
Netherlands Journ. Plant Path. 79: 85. 1973.

Aerial mycelium more abundant in cultures than is common in most species of the genus; chlamydospores scarce, inconspicuous. Conidiophores simple or branched, progressively geniculate at multiple conidiogenic loci. Primary sporulation abundant; secondary sporulation fairly common.

Conidia ovoid, ellipsoid, or subcylindroid, often with apical cell of ovoid conidia strongly conoid; straight, sometimes slightly inequilateral; ovoid conidia 20-27 x 8-11µm, with 3-4 transverse and 1-2(-3) longitudinal septa; subcylindroid conidia 32-36(-45) x 9-10µm, with 5-7(-8) transverse and 0 or uncommonly 1-2 longitudinal septa; medium golden or olivaceous brown with darker septa; essentially smooth. The ovoid or short ellipsoid pattern of conidium form dominates field material; longer, narrower forms become prominent in artificial culture.

Sources of specimens and isolates include bulbs and leaves of *Hyacinthus*, *Muscari*, *Freesia*, and *Scilla*. Representative strains include EGS 19-102 (CBS 416.71, ex Type, on bulb of *Hyacinthus orientalis*, Lisse, Netherlands, 1970); EGS 19-110 (R. Schneider, ex leaf of *Hyacinthus*, W. Germany, 1972).

EMBELLISIA INDEFESSA Simmons, *sp. nov.* Fig. 8, 23-24

Ex cultura in agaro PCA descripta. Mycelium in substrato immersum, sparsum, parce conidiogenum. Chlamydosporae deficientes. Conidiophora aeria simplicia, plerumque uniporosa. Sporulatio primaria numero conidiophoris

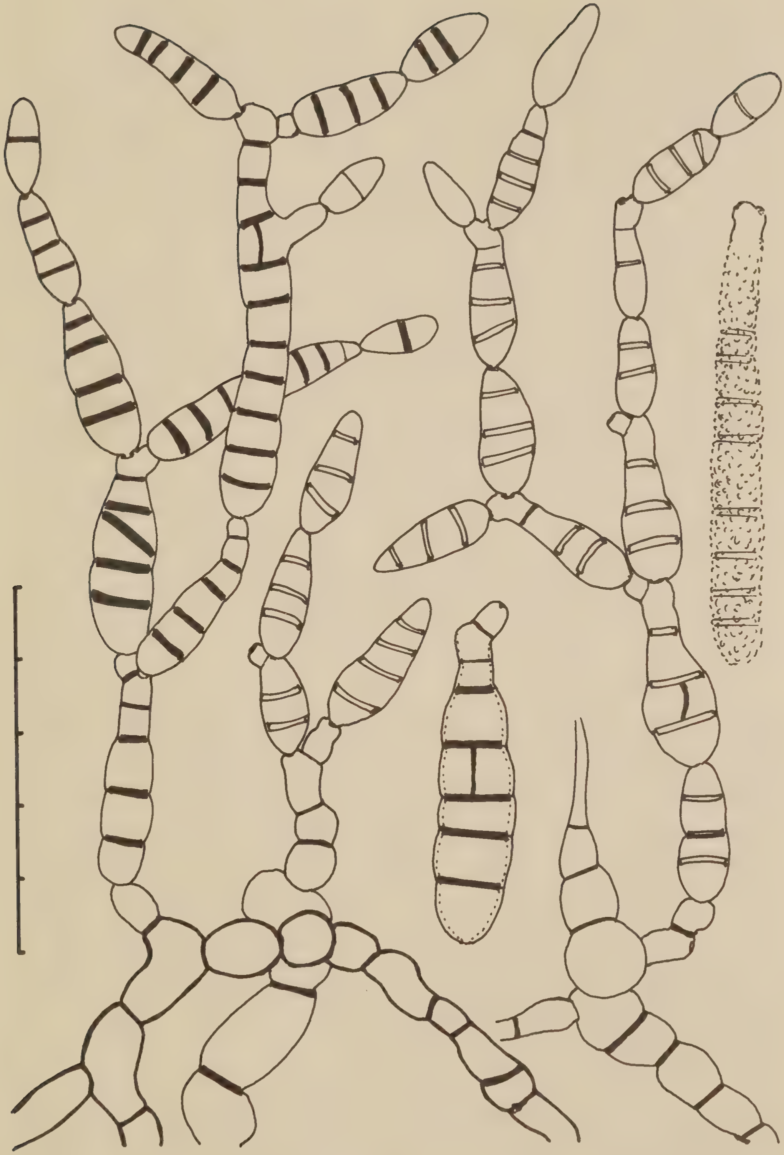


Fig. 8. Embellisia indefessa, EGS 30-195, PCA (Type).
Magn.: full line = 50µm.

primariis aequalis; sporulatio secondaria in systemate ramificatione arborescente valde copiosa. Conidia plerumque breviovoidea, recta, septis transversalibus 3-4 et longitudinalibus 0-1(-2), ca. 20 x 8µm, pallide vel parce aureobrunnea, levia; vel raro accrescentia, longiovoidea (ad 40 x 10µm) vel longicylindroidea (ad 60 x 7µm), verruculosa. TYPUS: partes ex E. G. Simmons 30-195 (leg. J. States ex solo, Arizona, 1973) desiccatae et in BPI (holotypus) et pro isotypis saltem in IMI et NY conservandae.

Conidiophoric mycelium almost totally within substrate, sparse, branching, hyaline, with submerged hyphal tips becoming darker and acting as conidiophores or emerging as uncrowded aerial conidiophores, each of which readily gives rise to an arborescent system of branching chains of conidia. Several adjoining cells of submerged hyphae may become distinctly swollen and moniliform, but distinctive clumps of darkened chlamydosporic cells have not been seen. Aerial conidiophores simple, few-celled, usually with a single apical conidiogenic locus. Primary aerial sporulation essentially equal to the number of primary conidiophores; secondary sporulation exuberant, with 10 or more conidia in single linear branches (commonly 50-100 conidia in the branching system atop a single conidiophore). Submerged conidiophores common, usually producing a single conidium each.

Conidia predominantly short ovoid, a few becoming long ovoid, long ellipsoid, or long cylindroid; straight or slightly inequilateral; mostly with 3-4 transverse and 0-1 (-2) longitudinal septa; very commonly about 20 x 8µm, uncommonly as large as 40 x 10µm (long ovoid) or 60 x 7µm (long cylindroid); pale to medium golden brown; smooth, or largest conidia becoming conspicuously verruculose. Secondary sporulation by means of a conidium apex becoming converted into a 1-celled or 1-2-geniculate conidiophore, or commonly as serial production of conidia without intervention of morphologically distinct secondary conidiophores.

Representative isolate EGS 30-195 (J. States, ex soil under sagebrush, Page, Arizona, 1973.

EMBELLISIA OXALIDICOLA Simmons, *sp. nov.* Fig. 9, 22

Conidiophora in laesionibus foliorum sparsa, simplicia, 2-5-geniculata, usque ad 50 x 4µm, aureobrunnea, cicatricibus umbilicatis fuscis. Chlamydosporae et sporulatio secondario indeprensae. Conidia ovoidea, lateraliter symmetrica, saepe apice conoidea, septis transversalibus 3-4 et longitudinalibus 0-2, vulgo 20 x 9 (max. 25 x 10)µm, aureo-

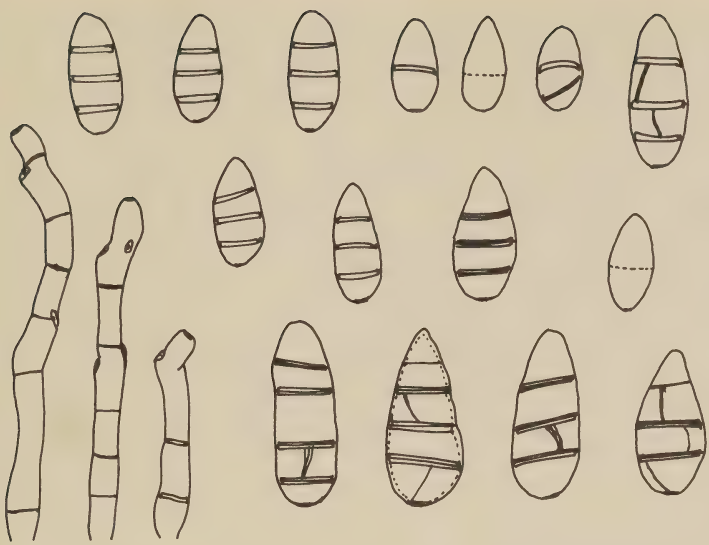


Fig. 9. Embellisia oxalidicola, EGS 30-026, from Type specimen. Magn. as Fig. 10: full line = 50µm.

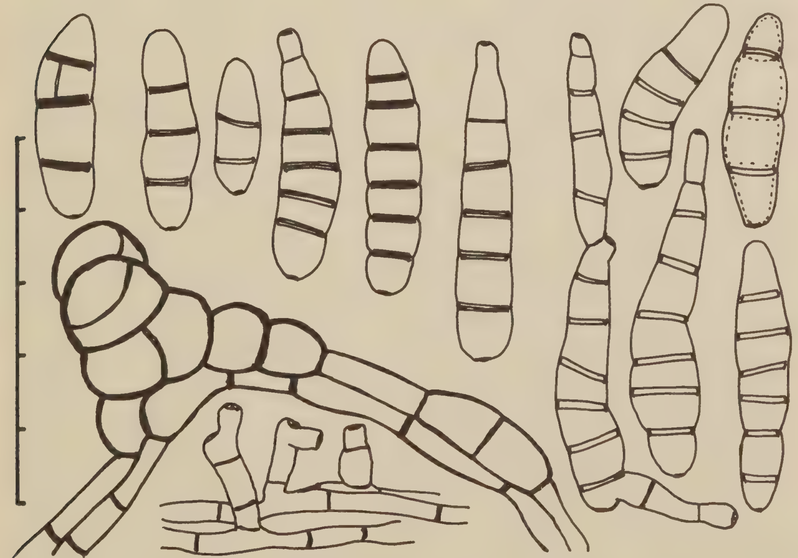


Fig. 10. Embellisia phragmospora, EGS 27-098, from PCA (Type). Magn.: full line = 50µm.

brunnea, plerumque levia. TYPUS: IMI 136725 (leg. N. K. Patel, in foliis Oxalidis latifoliae, XII-1968, no. 3433 ex National Agricultural Laboratory, Nairobi, Kenya), partes in Herb. IMI (holotypus) et in BPI (Simmons 30-026, isotypus) conservandae.

Known only from field collections of spotted leaves of *Oxalis*. Conidiophores sparse on pale brown, circular or angular lesions up to ca. 1 cm diam; simple, progressively geniculate at 2-5 conidiogenic loci; up to ca. 50 x 4µm; medium golden brown with darker umbilicate scars. No evidence of secondary sporulation.

Conidia ovoid, laterally symmetric, often with obtusely conoid apex; 3-4 transverse and 0-2 longitudinal septa; commonly 20 x 9µm, with well-defined maximum of 25 x 10µm; medium golden brown with darker septa; smooth.

Field specimens EGS 30-026 (National Agricultural Laboratories, Nairobi, Kenya, no. 3433, on leaves of *Oxalis latifolia*, leg. N. K. Patel, Dec. 1968 [IMI 136725 typus]); EGS 30-025 (on leaves of *O. latifolia*, leg. M. Mogk, Kenya, 1967 [IMI 131332]).

EMBELLISIA PHRAGMOSPORA (van Emden) Simmons, *comb. nov.* Fig. 10, 25

≡ *Alternaria phragmospora* van Emden, Acta Botanica Neerlandica 19: 393. 1970.

J. H. van Emden published one of the best, most comprehensive treatments of any *Embellisia* when he described *A. phragmospora*. His taxonomic judgement of his fungus may have been swayed unduly by advice he was given in 1969 by M. B. Ellis and E. G. Simmons. In any case, repetitive secondary sporulation tilted the generic balance at the time in favor of *Alternaria*, and it was not until two years later that sufficient specimens and observations had accumulated to support segregation of *Embellisia* (Simmons 1971).

Chlamydosporic groups of cells common, developing as enlarged, thick-walled, pale to dark reddish brown proliferations of adjoining hyphal cells and aerial hyphal tips; one to all cells of conidia vera also frequently becoming chlamydosporic; small but conspicuous, discrete tubercles developing on some chlamydospore cell walls. Primary conidiophores simple hyphal branches, pale, with one or very few conidiogenic loci, and usually not becoming strongly geniculate or branched; up to ca. 75 x 4µm. Primary sporulation abundant; secondary sporulation very abundant.

Conidia narrowly long ovoid or long obclavoid; straight, slightly inequilateral to definitely curved and even sigmoid; 3-5(-9) transverse and 0 (very rarely 1) longitudinal septa; often slightly constricted at septa; 25-38 (-50) x 8-10(-12)µm; pale yellowish to darker reddish brown with much darker septa; mostly smooth, rarely developing some roughness on basal cell; secondary conidiophore almost always a single (rarely 1-2-geniculate), pale, apical conidium cell, which generates secondary conidia in short to long chains of 10 or more units. Exceptionally, secondary conidiophores may be lateral or basal rather than apical; also, broadly holoblastic conidioid elements arise as striking exceptions among the great majority of typical conidia with their narrowly isthmic conidiophore connectives. (See excellent illustrations in van Emden 1970, Plate 1.)

Representative isolates EGS 27-098 and 27-099 (J. H. van Emden 2735 and 4285, Zuider Zee polder soil; Wageningen, Netherlands, July 1969 [IMI 141570 and 141571]; and EGS 31-030 (A. F. Moustafa, ex soil of salt marsh, Kuwait [via CBS, 1973]).

EMBELLISIA PLANIFUNDA Simmons, *sp. nov.* Fig. 11, 26

Ex cultura in agaro PCA descripta. Chlamydosporae multicellulares ex hyphis vegetativis evolutae, conidiophora aut hyphas vegetativas efferentes. Conidiophora simplicia, conspicuo geniculata et locis conidiogenis ca. decem. Sporulatio primaria abunda; sporulatio secondaria infrequens in conidiophoris secondariis locis conidiogenis 2-3. Conidia ellipsoidea vel ovoidea, fundo proprie lato et plano, lateraliter symmetrica, septis transversalibus 3(-4) et longitudinalibus 2(-3), 20-28 x 10-13µm, aureobrunnea, apparenter levia. TYPUS: partes ex Simmons 17-138 (leg. H. L. Harvey WA 257 ex semine tritici, Western Australia, 1965 [IMI 115034] desiccatae et in BPI (holotypus) et pro isotypis saltem in IMI et NY conservandae.

Multicellular chlamydosporic growths develop from vegetative hyphae, giving rise to conidiophores or simply attenuating and continuing growth as ordinary hyphae. Conidiophores simple, developing into multiseptate, conspicuously geniculate aerial branches with 10 or more conidiogenic loci. Primary sporulation good; secondary sporulation infrequent on short secondary conidiophores with 2-3 conidiogenic loci.

Conidia ellipsoid, becoming ovoid with a characteristically broad, flat base; laterally symmetric; 3(-4) transverse and usually at least 1 or commonly 2(-3) longitudinal or oblique septa; 20-28 x 10-13µm, diagnostic flat-based, ovoid conidia 23-24 x 12-13µm; color medium golden brown with slight olivaceous shade; apparently smooth.

Representative isolate EGS 17-138 (CMI 115034, H. L. Harvey WA 257, ex surface-sterilized wheat seed, Western Australia, 1965). A later isolate from wheat rhizosphere in Western Australia has conidia of the same diagnostic shape, with flat base, but has not been seen to produce distinctive chlamydospores; EGS 31-020 (K. Sivasithamparam W349, Nedlands, 1973).

EMBELLISIA TELLUSTER Simmons, *sp. nov.* Fig. 12, 28

Ex culturis in agaris PCA et V-8 descripta. Chlamydosporae nullae aut inconspicuae; spirae hypharum conidiophoricae aliquando visae. Conidiophora simplicia vel ramosa, plerumque 4-5-geniculata in locis conidiogenis. Conidia longe ovoidea vel longe ellipsoidea, recta, diverse inaequilatera aut sigmoidea, aliquando ramosa, septis transversalibus 5-7(-10) et longitudinalibus 0(-1), 25-40 x 8-10µm, aureobrunnea, levia. Conidiogenesis plerumque anguste poratim, sed etiam vulgo late holoblastica in forma conidiodea. TYPUS: partes ex Simmons 33-026 (leg. J.States RMF 2130, ex solo, Wyoming, 1965) desiccatae et in BPI (holotypus) et pro isotypis saltem in IMI et NY conservandae.

Chlamydospores lacking, or developing as inconspicuous groups of swollen hyphal cells; hyphal coils bearing conidiophores sometimes present. Conidiophores simple or branched, mostly becoming 4-5-geniculate at conidiogenic loci. Primary sporulation abundant; secondary sporulation uncommon but occasional by means of a secondary conidiophore at apex or lateral to the basal pore of primary conidia.

Conidia long ovoid or long ellipsoid; straight, slightly to decidedly inequilateral, or sigmoid, sometimes branched; 5-7(-10) transverse and 0 or rarely 1 longitudinal septa; 25-40 x 8-10µm; pale to medium golden brown; smooth. Conidiogeny is primarily poric at a restricted locus; but very commonly conidioid elements occur that are morphologically indistinguishable from porogenic conidia except that they are broadly holoblastic in origin.

Representative isolates EGS 33-026 (J. States RMF 2130, ex soil of sagebrush grasslands, Wyoming, 1965); EGS 31-031 (A. F. Moustafa, ex soil of salt marsh, Kuwait [via CBS, 1973]). Included also (with some misgiving, because I usually do not study these kinds of hyphomycetes on high-carbohydrate content media) is an herbarium specimen dried from an old potato-dextrose agar culture, EGS 33-111 (E. Kerry, ex soil, Bunger Hills, Antarctica, 1977 [IMI 215092]).

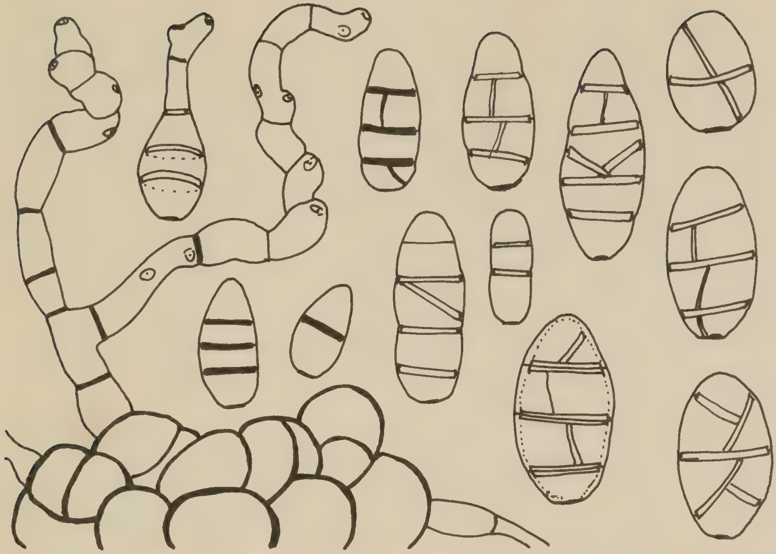


Fig. 11. Embellisia planifunda, EGS 17-138, from PCA (Type). Magn. as Fig. 12: full line = 50μm.

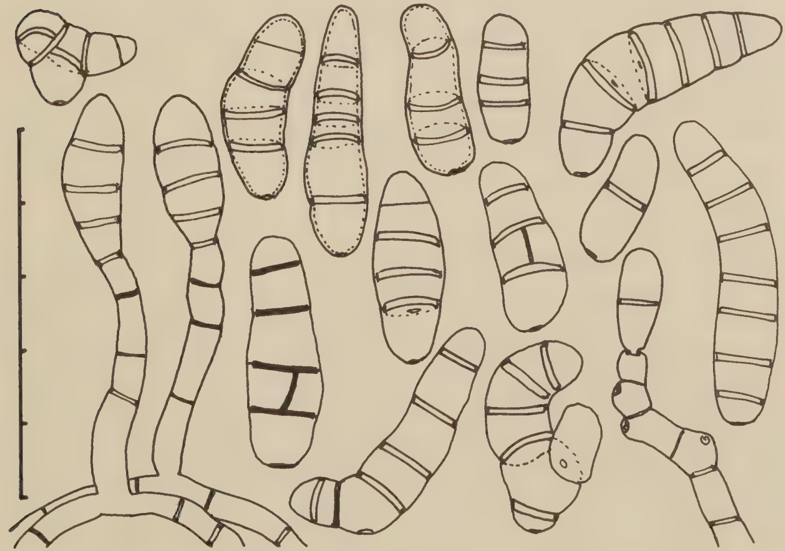


Fig. 12. Embellisia telluster, EGS 33-026, from V-8 agar (Type). Magn.: full line 50μm.

EMBELLISIA TUMIDA Simmons, *sp. nov.* Fig. 13, 29-30

Ex culturis in agaris PCA et V-8 descripta. Chlamydosporae abundae in catenis simplicibus vel subhelicoramosis. Conidiophora simplicia, ca. 5µm diam. et vulgo plus quam 40-50µm long., ad locos conidiogenos aliquot geniculata. Sporulatio primaria abunda; sporulatio secondaria indeprensa. Conidia longe ovoidea, ellipsoidea, plerumque recta, septis transversalibus 3-5 et longitudinalibus (0-)1(-2) in 3-4 cellulis primariis transversalibus, conspicue constricta ad septa transversa, 35-42 x 13-18µm, mediocria aureobrunnea, levia vel asperitate minuta. TYPUS: partes ex Simmons 31-019 (leg. K. Sivasithamparam G14, ex solo in radicivicinia tritici, Nedlands, Western Australia, 1973) desiccati et in BPI (holotypus) et pro isotypis saltem in IMI et NY conservandae.

Chlamydospores abundant, developing as chains of inflated, thick-walled, variously septate cells and as contorted, subhelical, branching chains of such cells. Conidiophores simple, 40-50 x 5µm, becoming longer, progressively geniculate and contorted at several conidiogenic loci. Primary sporulation moderate; no evidence of secondary sporulation.

Conidia long ovoid, ellipsoid, straight or rarely slightly inequilateral, conspicuously constricted at 1 or more of the 3-5 transverse septa; sometimes 0, but also 1(-2) longitudinal or oblique septa in 3-4 of the primary transverse compartments; 35-42 x 13-18µm; medium golden brown; smooth or with minor roughness.

Representative isolate EGS 31-019 (K. Sivasithamparam G14, ex wheat rhizosphere, Nedlands, Western Australia, 1973).

EMBELLISIA VERRUCULOSA Simmons, *sp. nov.* Fig. 14, 27

Ex cultura siccata in agaro "potato-dextrose" descripta. Chlamydosporae catenulatae, interdum inordinate verrucosa. Conidiophora simplicia, 1-2-geniculata in locis conidiogenis. Sporulatio primaria ut videtur sparsa; sporulatio secondaria sparsissima. Conidia longe ovoidea, obovoidea vel ellipsoidea, recta vel paulo inaequilatera, septis transversalibus 3-5(-6) et longitudinalibus (0-)1-3, 25-40 x 11-14µm, rubrobrunnea, aspra vel denique dense verruculosa. TYPUS: IMI 167906 (leg. M. J. Griffin, ex Alstroemeria sp., Great Britain, 1972), partes in IMI (holotypus) et in BPI (EGS 33-110, isotypus) conservandae.

Known only from an herbarium specimen of a culture

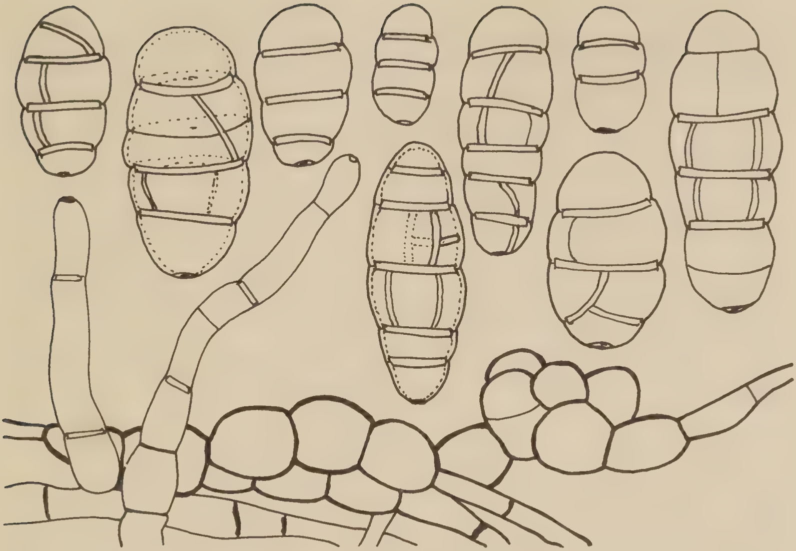


Fig. 13. Embellisia tumida, EGS 31-019, from V-8 agar (Type). Magn. as Fig. 14: full line = 50μm.

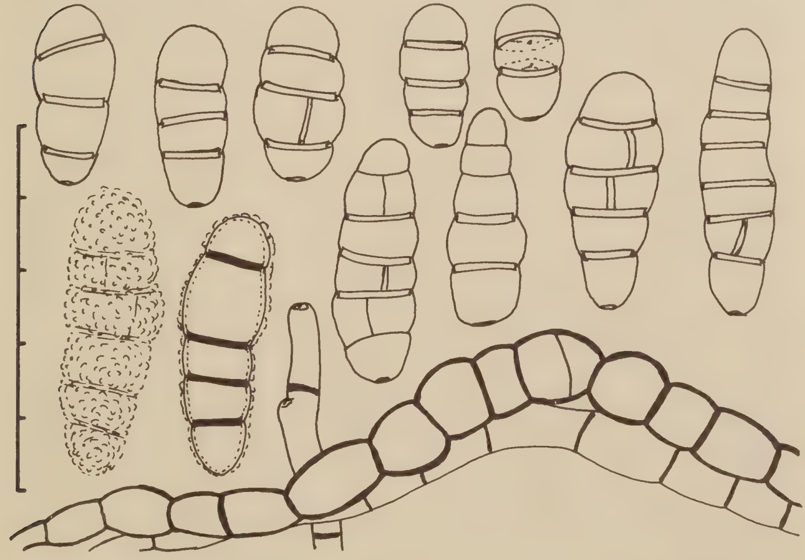


Fig. 14. Embellisia verruculosa, EGS 33-110, from Type specimen. Magn.: full line = 50μm.

dried after several weeks growth on potato-dextrose agar. Chlamydospores occurring as chains of adjacent hyphal cells that have become enlarged and thick-walled; walls sometimes irregularly verrucose, as are walls of some vegetative hyphae. Conidiophores simple, becoming 1-2-conidiogenic and geniculate. Primary sporulation apparently not very abundant; very scarce instances of secondary sporulation.

Conidia becoming elongate ovoid, obovoid, or ellipsoid; straight or slightly inequilateral; 3-5(-6) transverse and (0-)1-3 longitudinal septa; 25-40 x 11-14µm; reddish brown, darker than most conidia of other *Embellisia* species; becoming densely verruculose, almost to the point of obscuring the septation in largest conidia.

A single specimen, EGS 33-110 (M. J. Griffin, ex *Alstroemeria sp.*, Great Britain, 1972 [IMI 167906]).

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Dr. Martha Christensen and Dr. Jack S. States have been generous in sharing excellent Wyoming and Arizona soil isolates with me for this study. Doctor Christensen also has done me the considerable favor of reviewing the next-to-last draft of this paper's manuscript. I am grateful also to the many geographically diversely situated individuals whose problematic cultures and specimens have instigated this work. Funds of National Science Foundation Grant DEB 79 04189 continue to support this and other generic studies.

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Figures 15-30. All at the same magnification; line length in Figs. 19 and 27 = 50µm.

Fig. 15. *E. abundans*, emphasizing evidence of secondary sporulation; ex Type.

Fig. 16. *E. allii*, emphasizing absence (rarity) of longitudinal septa and of secondary sporulation; ex Representative culture.

Fig. 17. *E. chlamydospora*, with bulky chlamydospore clump shadowy at left; ex Representative culture.

Fig. 18. *E. chlamydospora*, with characteristic hyphal coil.

Fig. 19. *E. conoidea*; ex Type.

Fig. 20. *E. didymospora*, emphasizing dominance of 2-celled conidia; ex Type.

Fig. 21. *E. hyacinthi*; ex Type.

Fig. 22. *E. oxalidicola*, group of conidia and conidiophores on natural substrate; ex Type.

Fig. 23. *E. indefessa*, conidiophores, primary conidia (characteristically solitary), and somewhat inflated hyphae produced within agar substrate; ex Type.

Fig. 24. *E. indefessa*, minor portions of typical conidium chains from a complexly branched system of aerial sporulation; ex Type.

Fig. 25. *E. phragmospora*; ex Type.

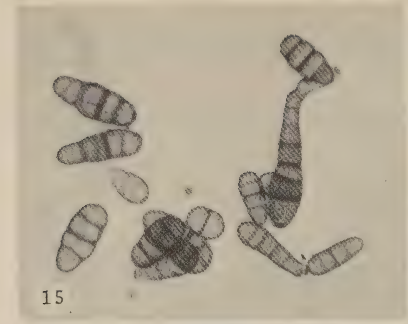
Fig. 26. *E. planifunda*; ex Type.

Fig. 27. *E. verruculosa*; ex Type.

Fig. 28. *E. telluster*, with characteristic conidioid element (lower left) and hyphal coil; ex Type.

Fig. 29. *E. tumida*; ex Type.

Fig. 30. *E. tumida*, illustrating characteristic pattern of septum fracture, which may occur when pressure is applied to a conidium.



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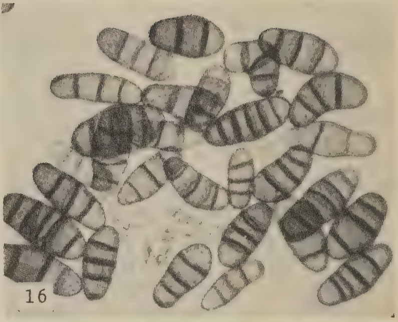

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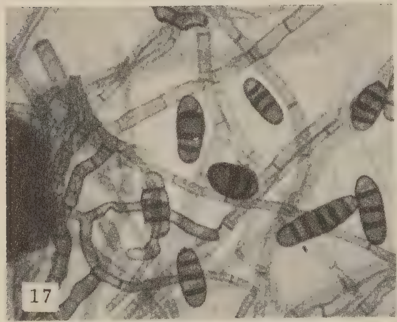

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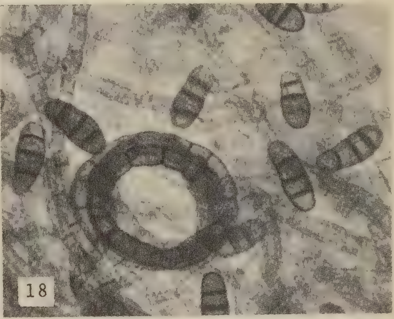

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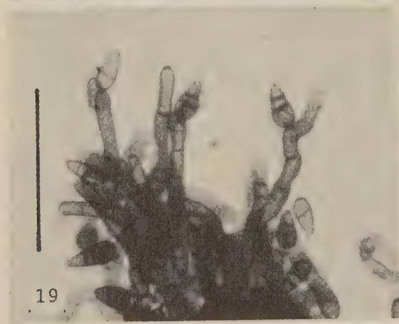

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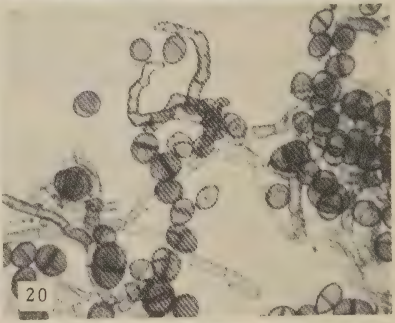

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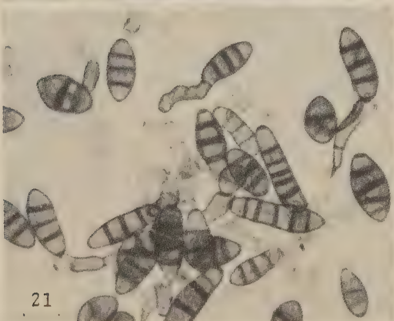

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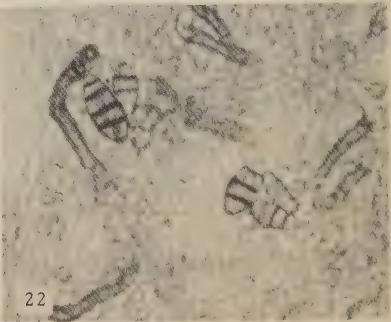

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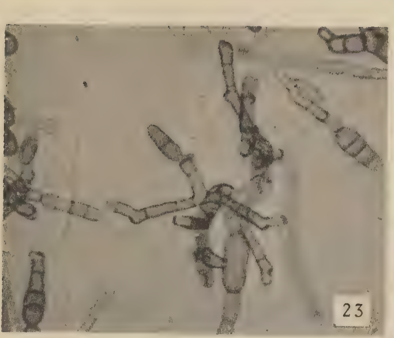
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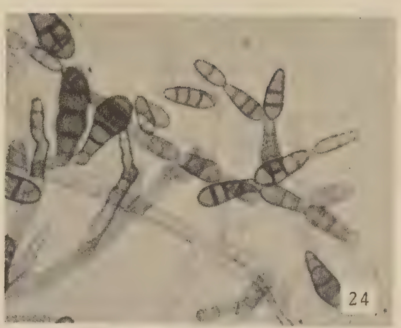
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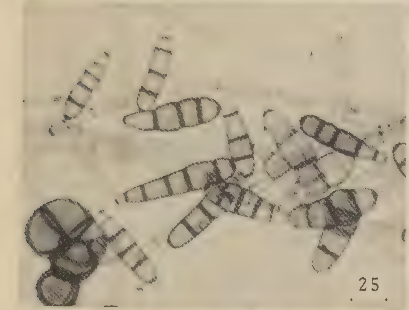
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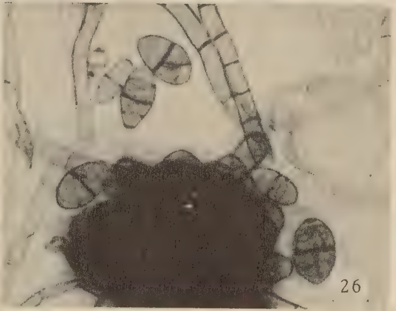
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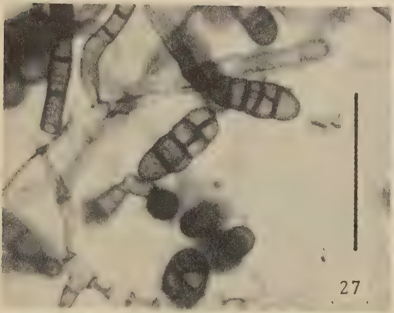
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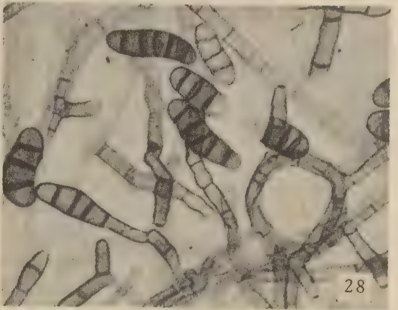
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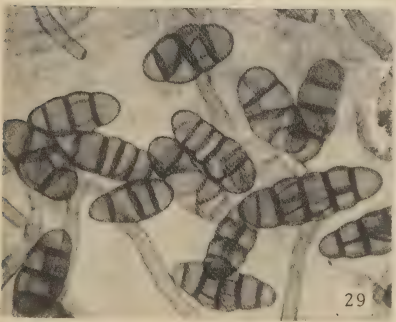
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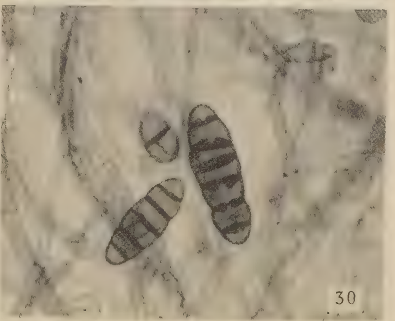
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A NEW BELTRANIELLA SPECIES FROM TROPICAL FOREST LITTER

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Summary

In this paper a new species of the genus Beltraniella (Dematiaceous Hyphomycetes), B. clara sp.nov., is described.

During mycological investigations carried out within the Tai project of the M.A.B. program, a new species of the genus Beltraniella Subramanian (1952) on the tropical rain forest litter in the Ivory Coast, was discovered. The morphological description is based on characteristics observed on natural media. The Exsiccatum is deposited in the Herbarium of the Istituto dell'Orto Botanico of Rome (H.B.R.).

Beltraniella clara sp.nov.

Coloniae effusae, subalbae, circumscriptae. Mycelium immersum. Conidiophora setiformia, macronematosa, mononematosa, erecta, recta vel modice flexuosa, levia, solitaria, simplicia vel ramosa, 5-7 saeptata, ad basim modice inflata, interdum lobata, apice rotundato; 1-3 cellulis conidiogenis vel ramis, 1-3 cellulis conidiogenis praeditis, infra saeptum praedita ; subhyalina vel pallidissime flava; 90-150 µm longa et 4-5,5 µm ad basim crassa. Saepe cellula initialis conidiophori, semel vel bis in ramos exit et fert aliquot cellulas conidiogenas. Rami: 7-18x3,5-5,5 µm. Cellulae conidiogenae orientes in verticillis a conidiophororum cellulis, praeter apicales, aut a ramibus, discretae, pleurogenae, polyblasticae, subglobosae vel ovatae, denticulatae, hyalinae; 6-7,5(13)x4-5,5 µm. Conidia continua, levia, solitaria, lagoeniformia, rostrata, subhyalina, protoplasmate granuloso; 18-20,5x5,5-7,5 µm.

In foliis emortuis, Tai, Ora Eboris, holotypus: H.B.R. 123A

Colonies effuse, whitish, circumscribed. Mycelium immersed. Conidiophores setiform, macronematous, mononematous, erect, straight or slightly flexuose, smooth, solitary, simple or branched, 5-7 sep-

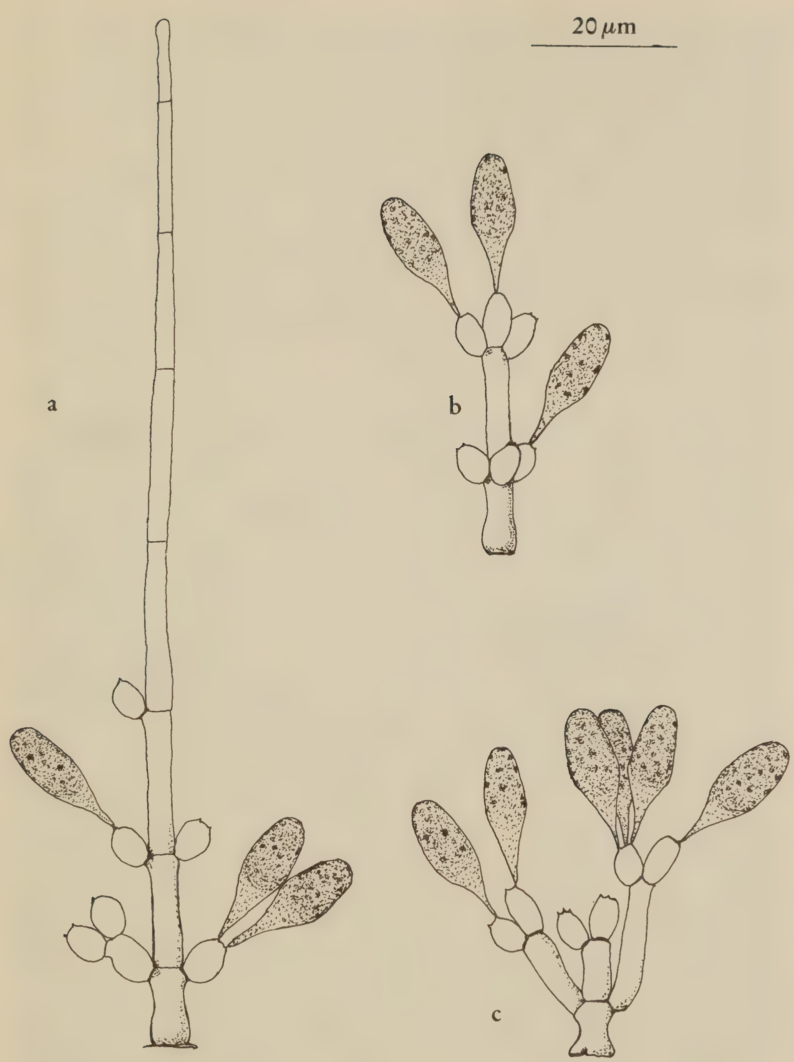

Fig. 1 - Beltraniella clara: a. Setiform conidiophore with conidia; b. and c. Non-setiform conidiophores with conidia.

tate, slightly inflated near the base, sometimes lobed, rounded at the apex, bearing directly 1-3 conidiogenous cells or, rarely, branches with 1- 3 conidiogenous cells, which are produced by 1 or more cells, never from the apical one, in verticils just below the septa; subhyaline to pale olive-yellow (Primrose Yellow: Pl. XXX, Ridgway, 1912); 90-150 µm long and 4-5.5 µm wide near the base. Often an initial cell, instead of developing into a seta, branches 1-2 times to produce a group of conidiogenous cells. Branches 7-18x3.5-5.5 µm. Conidiogenous cells in verticils immediately below the septa of the cells of the setiform conidiophore or on branches, discrete, pleurogenous, polyblastic, subglobose or ovoid, with 1-3 small denticles, hyaline; 6-7.5 (13)x4-5.5 µm. Conidia continuous, smooth, solitary, lageniform ; proximal end rostrate, distal free end rounded; subhyaline, with granular protoplasm; 18-20.5x5.5-7.5µm.

The described species can be included in the genus Beltraniella Subramanian (1952). It presents affinities with the type species B. odinae Subramanian (1952), as described by Pirozynski (1963), mainly in the shape and dimensions of its non-setiform conidiophores, but it differs in the shape of the setiform conidiophores and of the spores. Moreover B. odinae has separating cells, conidia with transverse band and is pigmented. There are also affinities with the species B. porosa Pirozynski et Patil (1970), in which nevertheless there are separating cells and subhyaline, circular pores on the conidia. It differs also in shape and color of spores.

B. clara presents greater affinities with the species B. pirozynskii P. M. Kirk (1981), which has very similar setiform conidiophores and has no separating cells. But B. pirozynskii has only setiform conidiophores, all pigmented, with definitely lobed basal cells. Moreover in B. clara the conidiogenous cells are smaller and subglobose, and conidia are lageniform, colorless, smaller and without any transverse band.

For the reasons above mentioned B. clara is proposed as a new species.

This research has been carried out within the Tai project: Effects of increasing human activities on South Western Ivory Coast tropical rain forest, UNESCO, M. A. B. Program, Project n°1.

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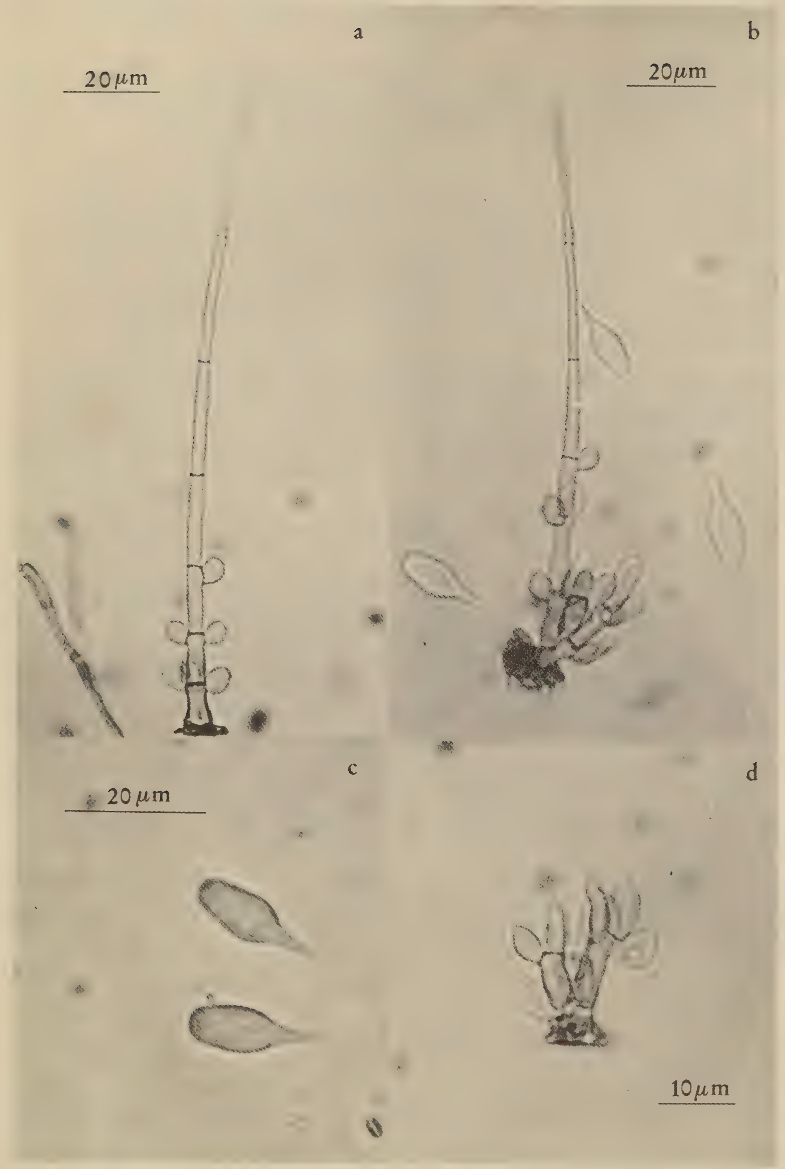
a
b
c
d
20µm
20µm
20 µm
10µm

Fig. 2 - Beltraniella clara: a. and b. Setiform conidiophores; c. Conidia; d. Non-setiform conidiophore.

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MYCOTAXON

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TWO NEW SPECIES OF LOCULOASCOMYCETES

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ACANTHOSTIGMELLA

For many years, the junior author has collected a small hypersaprobic fungus on old stromata of *Hypoxylon deustum* (Fr.) Grev. (*Ustulina vulgaris* Tul. & Tul.). The bitunicate asci remove the species from consideration as a member of the Hypocreales, although several species of *Nectria* are hypersaprobic on other ascomycetes. The small size, soft texture, presence of periphysoids, and asci with thickened apex are all characteristic of members of the Herpotrichiellaceae, order Chaetothyriales (Barr 1979). The faint pigmentation of peridium and the short hyaline setae suggest *Acanthostigmella pallida* Dennis & Barr but the dimensions are considerably larger than for that minute species. None of the species recognized by Barr (1977) in *Acanthostigmella* fits exactly with the fungus on *Hypoxylon*; pigmentation and sizes as well as habit are sufficiently different to proclaim a new species.

Acanthostigmella brevispina Barr & Rogerson, sp. nov.
Figs. 1-4

Ascomata (112-)130-180 µm diametro, 140-160(-210) µm alto, hyalinae vel flavae, setis hyalinis 20-40(-44) µm longis crassotunicatis ornatis. Asci (33-)50-65(-70) x (6-)8-10 (-14) µm. Ascosporae (13-)14-18(-21) x (3.5-)4-5(-7) µm, hyalinae, fusiformae, 3-septatae.

Status anamorphis: hyphae hyalinae caespitosae; cellularis conidiogenarum holoblasticae ut rami brevi; conidia (40-) 50-100(-162) x 2.5-4.5 µm, hyalinae fusiformae 3-5-7-14-phragmoseptatae.

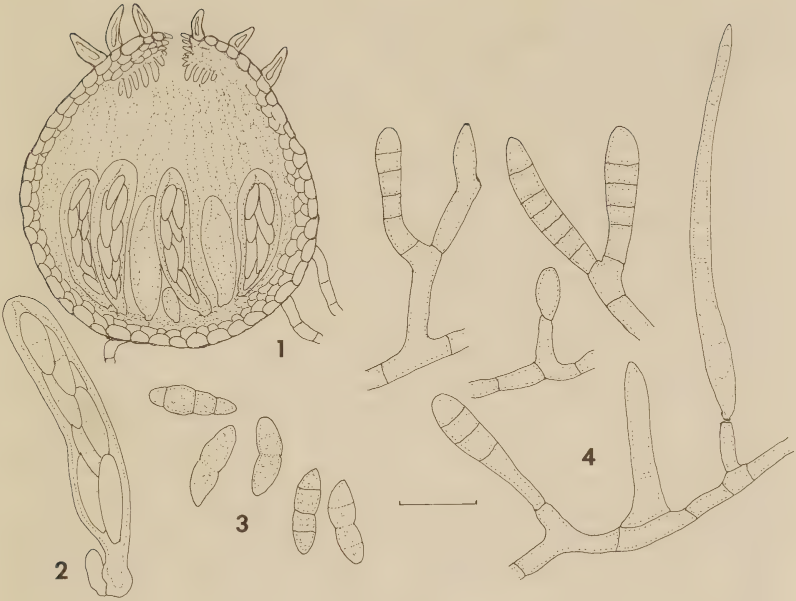
Holotypus insidens *Hypoxylo deusto*, ad "New York, Essex Co., along Johns Brook Trail, west of Keene Valley, 15 Aug 1970" a C. T. Rogerson n. 70-111 et G. J. Samuels lecti (NY; isotypus MASS).

Ascomata (112-)130-180 µm diam, 140-160(-210) µm high, globose with short papillate apex, hyaline to pale yellow, superficial, with hyaline, thick-walled setae 20-40(-44) µm long, basal cell 10-20 µm wide, wall thickened, lumen narrow; peridium narrow, 10-14 µm wide, composed of two or three layers of polygonal cells; apical pore lined with short periphysis-like cells. Asci basal, bitunicate, oblong, (33-)50-65(-70) x (6-)8-10(-14) µm, apex thickened. Pseudoparaphyses narrowly cellular above asci, often seen with free rounded ends, deliquescent at maturity, periphysoids short from apex of locule. Ascospores (13-)14-18(-21) x (3.5-)4-5(-7) µm, hyaline, fusoid, asymmetric, often inequilateral or slightly curved, 3-septate, constricted slightly at primary septum; wall thin, smooth, contents minutely guttulate; overlapping bi- or triseriate in the ascus.

Anamorph: on substrate and in culture hyaline hyphae forming whitish tufts or patches; holoblastic conidiogenous cells as short upright branches of recumbent hyphae; conidia hyaline, (40-)50-100(-162) x 2.5-4.5 µm, fusoid, 3-5-7-14-septate, base truncate, small denticulate scar on conidium and on conidiogenous cell.

On stromata of *Hypoxylon deustum* (Fr.) Grev., eastern North America.

Specimens examined (in NY except where noted): CANADA: QUEBEC: Rouville Co., Rougement Mt., 23 Aug 1959, Rogerson 59-40. ONTARIO: Haliburton Co., Univ. Toronto Experimental Forest, 8 miles south of Dorset, 8 Sep 1962, Rogerson 62-80; same locality, 1 Nov 1969, D. Malloch (TRTC 45652). USA: MASSACHUSETTS: Worcester Co., Prospect Hill tract, Harvard Forest, near Petersham, 17 Jun 1973, Rogerson 73-20. CONNECTICUT: Litchfield Co., woods 1 mile south of Caanan, 2 Nov 1959, Rogerson 59-62; along Butternut Brook, woods of White Memorial Foundation, southwest edge of Litchfield, 1 Oct 1978, Rogerson 78-181. NEW YORK: Essex Co., Twin Valley Camp, Plattsburg State College, near Wadhams, 2 Sep 1967, Rogerson s.n.; same locality, 9 Sep 1967, Rogerson 67-129; east of Schroon Lake, south of Severance, 26 Sep 1969, Rogerson, S. J. Smith and Moore s.n.; along Johns Brook Trail west of Keene Valley, 15 Aug 1970, Rogerson 70-111 and G. J.



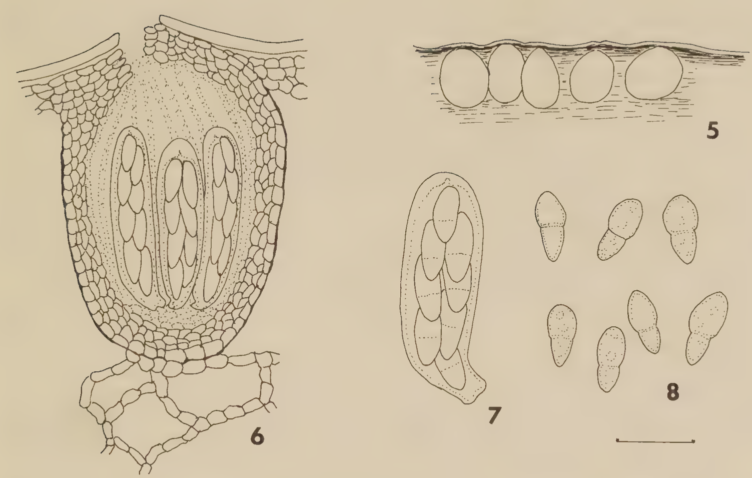
Figs. 1-4. *Acanthostigmella brevispina.* 1. Ascoma in vertical section. 2. Ascus. 3. Ascospores. 4. Conidia and conidiogenous cells from hyphae. Standard line = 40 µm in Fig. 1, 15 µm in Figs. 2-4.

Samuels (holotypus, isotypus - MASS); Franklin Co., Big Wolf Pond, 22 Jul 1958, Rogerson, S. J. Smith and Larsen s.n.; 2 miles west of Saranac Lake, 11 Sep 1965, Rogerson 65-71; Fulton Co., along Cranberry Creek, west side of Sacandaga Reservoir, 1 Oct 1970, Rogerson s.n.; Greene Co., near Kaaterskill Falls, Catskill Mountains, 18 Aug 1973, Rogerson 73-96 and S. J. Smith; Herkimer Co., east side of West Canada Creek, Trenton Falls, 19 Sep 1969, Rogerson, S. J. Smith and Moore s.n.; Otsego Co., 5 miles north of Oneonta, 22 Sep 1963, Rogerson 63-89; gorge, 1 1/2 miles north of Cherry Valley, 26 Sep 1970, Rogerson 70-171, S. J. Smith and Haines; Rensselaer Co., woods east of Cherryplain Park, 1 1/2 miles west of Route 22, 6 Aug 1966, Rogerson s.n.; woods near Schaghticoke, 1 Oct 1969, S. J. Smith 44948 and Moore; Rockland Co., along Stony Brook, east of Sloatsburg, Harriman State Park, 10 Oct 1965, Rogerson 65-113; Schuyler Co., Arnot Forest, 30 Oct 1949, Rogerson 3342 (Korf 1998); Tompkins Co., 1 mile east of Forest Home, near Ithaca, 5 Oct 1948, Rogerson 2755 (Korf 1997); woods southeast of airport, Ithaca, 9 Oct 1948, Rogerson and Trejo s.n. (Korf 1467); woods east of Cornell University Test Gardens, Cornell Plantations, near Ithaca, 11 Nov 1949, Korf 2009 (Rogerson 3332), Lloyd-Cornell Preserve, McLean, 5 Sep 1952, Rogerson s.n.; Michigan Hollow Swamp, near Danby, 20 Oct 1958, Korf 58-56; Warren Co., Pack Experimental Forest, north of Warrensburg, 3 Oct 1959, Rogerson 59-69 and S. J. Smith. MICHIGAN: Alger Co., woods west of Grand Sable Lake, 3 Aug 1971, Rogerson s.n.; Berrien Co., Warren Woods, 3 Sep 1955, Rogerson s.n.; Cheboygan Co., Carp Creek Gorge, near University of Michigan Biological Station, 29 Jul 1962, Rogerson 62-38; Colonial Point, Burt Lake, 29 Jul 1964, Rogerson s.n.; Chippewa Co., south of Whitefish Bay, Hiawatha National Forest, 11 Aug 1971, Rogerson s.n.; Emmet Co., 3 miles southwest of Cross Village, 5 Aug 1964, Rogerson s.n.; Luce Co., near upper Falls of Tahquamenon River, 25 Jul 1962, Rogerson 62-27; same locality, 3 Aug 1964, Rogerson 64-42. PENNSYLVANIA: Sullivan Co., Rickett's Glen, near Red Rock, 22 Oct 1961, G. Carroll s.n. OHIO: Delaware Co., Camp Lazarus Boy Scout Camp, 2 Sep 1968, Rogerson 68-111. INDIANA: Owen Co., McCormack's Creek State Park, 15 Aug 1981, M. E. Barr 6890 (MASS). TENNESSEE: Sevier Co., along Roaring Brook Trail, near Trillium Gap, Great Smoky Mountains National Park, 12 Aug 1968, Rogerson s.n.

The anamorph has the aspect of an unpigmented *Rhinocladiella atrovirens* Nannf.= *R. mansonii* (Castell.) Schol-Schwarz, described as the anamorph of *Dictyotrichiella mansonii* Schol-Schwarz (1968). *Dictyotrichiella* is also a member of the Herpotrichiellaceae and differs in gray-brown pigmentation of the muriform ascospores. In addition to the holoblastic state, *D. mansonii* produces a phialidic and an annellidic state, neither of which was seen in material of *Acanthostigmella brevispina*.

DIDYMELLA

A collection of *Thermopsis montana* Nuttall (Fabaceae) bore blackened crustose stromatic layers over several cm of stem. The numerous small ascomata seated beneath the covering and immersed in stem tissues contain pseudoparaphysate bitunicate asci and ascospores that are those of a species of *Didymella*. The blackened crustose stroma over the ovoid or globose ascomata are features that deviate from species of *Didymella*, but no other genus provides a better position. Ascomata of *D. trifolii* (Fckl.) Sacc. may be covered by a clypeus (Holm 1953) and be grouped together (Corbaz 1957),



Figs. 5-8. *Didymella stromatica*. 5. Outline of ascomata in stem tissues. 6. Ascoma in vertical section. 7. Ascus. 8. Ascospores. Standard line = 180 µm in Fig. 5, 28 µm in Fig. 6, 15 µm in Figs. 7, 8.

but the ascomata are typically depressed globose. In ascus and ascospore shape, *D. trifolii* also appears to be related to the species on *Thermopsis*, but sizes are greater in *D. trifolii*. None of the species that Corlett (1981) surveyed presents a haven for the present collection.

Bisby et al. (1938) recorded the presence of a fungus as *"Endodothella ? sp."* on stems of *Thermopsis rhombifolia* from Saskatchewan. According to the brief notes it could be identical with the species from Utah. Unfortunately the specimen was not available for examination. The genus *Endodothella* is not appropriate for this taxon; the type species belongs in *Phyllachora* and other species in *Stigmochora*, both Euascomycetes (Müller and von Arx, 1962).

Didymella stromatica Barr & Rogerson, sp. nov. Figs. 5-8

Stromata anthracina extensa caulicola; ascomata immersa numerosa globoso-ovoidea, 78-117 µm diametro et 104-117 µm alto. Asci bitunicati oblongi, 40-50 x 7-8 µm; pseudoparaphyses cellulosae. Ascosporae 12-15 x 4-5 µm, obovoideae uniseptatae sub median.

Holotypus ad caulibus mortuis *Thermopsis montanae* Nuttall, ad "Utah, Uintah Co., Green's Lake, Ashley National Forest, 29 May 1966" a C. T. Rogerson lecti (NY; isotypus MASS).

Stromatic layers forming rather shining black crust over several cm of stem, subepidermal, composed of heavily encrusted cells and short-celled hyphae that connect upper sides of adjacent ascomata; ascomata 78-117 µm diam, 104-117 µm high, globose or ovoid, apex minutely papillate; peridium narrow, 10-15 µm wide, composed of two or three layers of pseudoparenchymatous cells, hyphae of base developing from deep in substrate, hyphae from upper sides massed together to form stromatic layers. Asci basal, bitunicate, oblong, 40-50 x 7-8 µm. Pseudoparaphyses narrowly cellular. Ascospores 12-15 x 4-5 µm, hyaline becoming light dull brown at maturity, obovoid, apex obtusely rounded, tapering to more acute base, 1-septate, septum submedian, slightly constricted; wall with scattered roughenings; contents with two globules per cell; overlapping biseriate in the ascus.

On dead stems of *Thermopsis montana* Nuttall, Utah. Known only from the type collection.

We acknowledge with appreciation the critical review of the manuscript made by A. Y. Rossman.

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SPECIES OF EFFUSED APHYLLOPHORALES (BASIDIOMYCOTINA) FROM THE SOUTHEASTERN UNITED STATES

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SUMMARY

Six new species of Corticiaceae are proposed, described and illustrated. They are *Dendrothele bispora*, *Dendrothele subfusispora*, *Hyphoderma leoninum*, *Hyphoderma rimosum*, *Hypochnicium stratosum*, and *Peniophora sphaerocystidiata*. In addition, *Tubulicium capitatum*, a new combination, and *Steccherinum seriatum* are also described and illustrated. Cultural characters are provided for four species.

KEYWORDS: Corticiaceae, Hericiaceae, cultures, wood decay fungi, systematics, new taxa, Aphyllophorales, Basidiomycotina.

INTRODUCTION

Our studies of lignicolous fungi in the southeastern United States revealed six new and two additional infrequently collected species. They are described and illustrated, with cultural characters given for several of the species. Materials and methods are those described in Burdsall and Nakasone (1981).

DESCRIPTION OF SPECIES

1. *DENDROTHELE BISPORA* Burds. et Nakas., sp. nov. Fig. 1

Species hyphis systematis dimiticis; hyphis skeletis subiculis brunneis afibulatis; hyphis generatoriis fibulatis hyalinis; basidiis bisterigmatibus; basidiosporis obovatis 11-13.5 x 6-7.5 µm, a congeneribus diversa.

Holotypus: HHB 6762, on *Taxodium distichum* (L.) Rich., Hatchet Creek, Alachua County, Florida, leg. H. H. Burdsall, Jr., 27 VII 1972 (CFMR).

Basidiocarp annual, effuse in patches, coalescing into areas up to 6 x 2 cm, up to 0.2 mm thick, membranous, adherent; fertile areas

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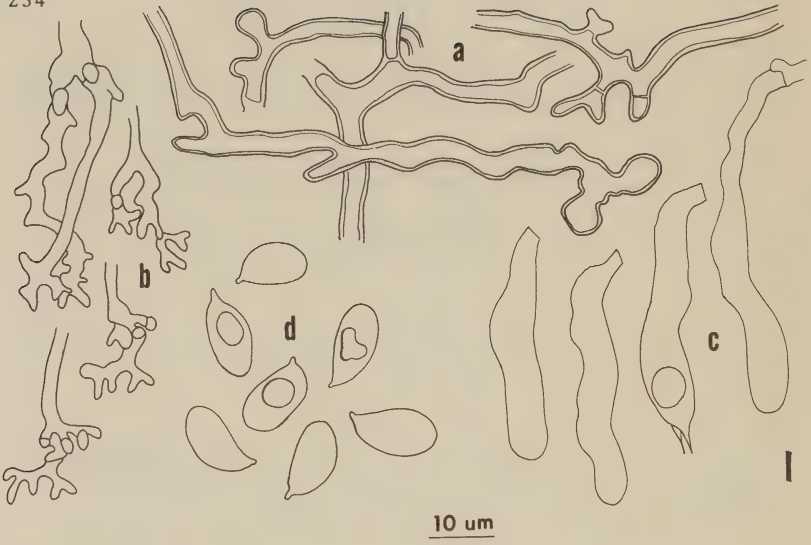
[1/] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.



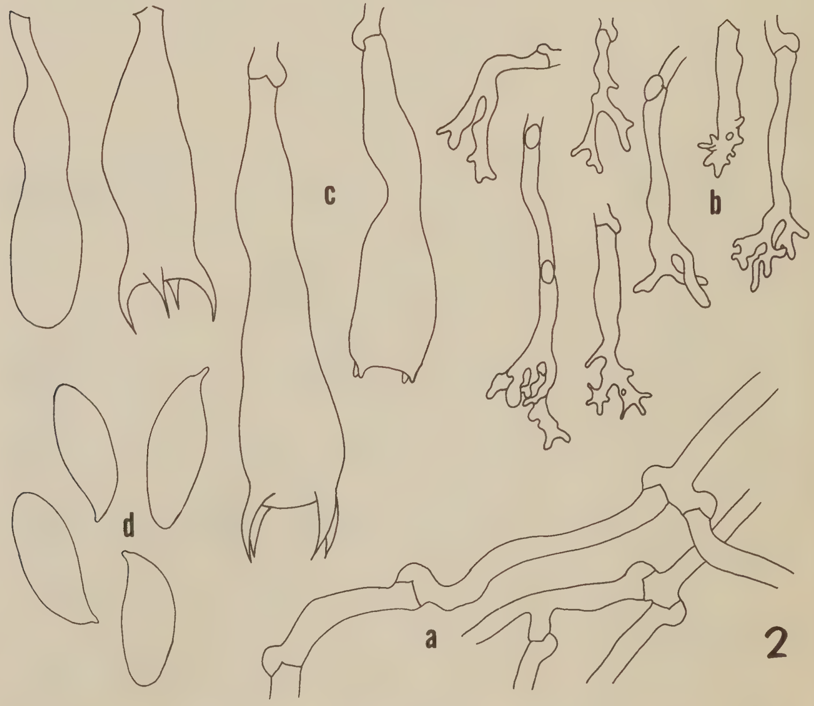


Fig. 1. Dendrothele bispora (HHB 6762, holotype): a. skeletal hyphae, b. dendrohyphidia, c. basidia, d. basidiospores. Fig. 2. Dendrothele subfusispora (HHB 6583, holotype): a. subhymenial hyphae, b. dendrohyphidia, c. basidia, d. basidiospores.

continuous, smooth, yellowish white (near 4A2) to orange grey (paler than 5B2); margin up to 2 mm broad, thinning, pubescent, irregular in outline, bicolored, olive on the inner portion and white on the edge; subiculum fibrous, olive-colored, about 200 µm thick.

Hyphal system dimitic. *Subiculum* a *textura intricata* mainly of skeletal hyphae, 2.5-3.5(-4) µm diam, thick-walled, brown, regularly to frequently branched, simple septate, smooth; generative hyphae difficult to observe, mainly located in the subhymenium, 2.5-3.5 µm diam, thin-walled, hyaline, regularly branched, nodose septate at some septa, smooth or densely encrusted with hyaline crystals; *subhymenium* not apparent; *cystidia* lacking; *dendrohyphidia* profuse, forming an epithecium through which basidia protrude, 1.5-2.5 µm diam, densely branched, thin-walled, surface densely encrusted with small hyaline crystals that often disperse when crushed in slide preparation; *basidia* clavate, 35 x 7-9 µm, thin-walled, hyaline, nodose septate at base, 2-sterigmate, sterigmata up to 9 µm long; *basidiospores* obovate, adaxially flattened, 11-13.5 x 6-7.5 µm, hyaline, smooth, thin-walled, Melzer's -, acyanophilous.

Etymology: From *bi* (L., comp. = two) + *spora* (L., n. = spore), referring to the two-spored basidia found in this species.

Specimen examined: Holotype cited above.

Remarks: *Dendrothele bispora* is unique in this genus in that it possesses brown skeletal hyphae. It shares the bisterigmate condition with *D. griseo-cana* (Pers.) Bourd. et Galz. and *D. commixta* (Hoehn. et Litsch.) Erikss. et Ryv.

2. *DENDROTHELE SUBFUSISPORA* Burds. et Nakas., sp. nov. Fig. 2

Differt a species *Dendrothele* apseudocystidiis; basidiis 40-80 x 10-15 µm; basidiosporis subfusiformibus; 18-24 x 6.5-9 µm.

Holotypus: HHB 6583, on *Ostrya virginiana* (Mill.) K. Koch, Upper Sugar Foot Prairie, Alachua County, Florida, leg. H. H. Burdsall, Jr., 14 VII 1972 (CFMR).

Basidiocarp annual, broadly effuse, covering underside of small twigs and branches, up to 0.5 mm thick, membranous, adherent; fertile areas continuous, smooth, yellowish white (2A2); margin up to 1 mm broad, pubescent to farinaceous, irregular in outline, white.

Hyphal system monomitic. *Abhymenial surface* 10-20 µm thick, a compact *textura intricata*, hyphae 2-3.5 µm diam, thin-walled, hyaline, regularly branched, nodose septate, smooth; *subiculum* 40-60 µm thick, a loose *textura intricata*, hyphae like those of abhymenial surface; *subhymenium* 20-40 µm thick, a compact *textura intricata*, hyphae 2-3 µm diam, thin-walled, hyaline, smooth, with frequent branching, nodose septate; *cystidia* lacking; *dendrohyphidia* cylindrical, densely branched at apex, 25-42 x 2.5-4.5 µm, thin-walled, hyaline, smooth, protruding up to 10 µm; *basidia* clavate, 40-80 x 10-15 µm, hyaline, thin-walled, nodose septate at base, 4-sterigmate, sterigmata up to 12 µm long, 3 µm diam at base; *basidiospores* subfusiform to fusiform elliptical, 18-24 x 6.5-9 µm, hyaline, thin-walled, smooth, Melzer's - or with possible slight amyloidity, acyanophilous.

Etymology: From *sub* (L., comp. = somewhat) + *fusiformis* (L., adj. = tapered toward both ends), referring to the shape of the basidiospores.

Specimen examined: Holotype cited above.

Remarks: The size and shape of its large subfusiform spores characterize *D. subfusispora* and prevent confusion with any of the other *Dendrothele* species.

3. HYPHODERMA LEONINUM Burds. et Nakas., sp. nov. Fig. 3

Species area fecunda bublina; margine zonata (zona externa alba et interiora olivaceis); hyphis systematis dimiticis; cystidiis clavatis, 50-100 x 6-8 μm, contentis refractis; structuris hymeniis similaribus dendrohyphidiis; basidiosporis anguste ellipsoideis, 5.5-7.5 x 2.5-3(-3.5) μm congeneribus diversa.

Holotypus: HHB 4063, on bark of Acer sp., Rainbow Falls Trail, Great Smoky Mountains National Park, Sevier County, North Carolina, leg. H. H. Burdsall, Jr., 29 VI 1970 (CFMR).

Basidiocarp annual, broadly effuse, up to 0.5 mm thick, membranous, rather tough and fibrous, adherent, cracking slightly in older areas; fertile areas continuous, smooth, pale orange (near 5A3) to brownish orange (near 5C6); margin about 1 mm broad, fimbriate, thinning, irregular in outline, bicolored, inner band brownish orange (near 5C6) with outer edge white; subiculum fibrous, and concolorous with fertile area or slightly paler and somewhat layered.

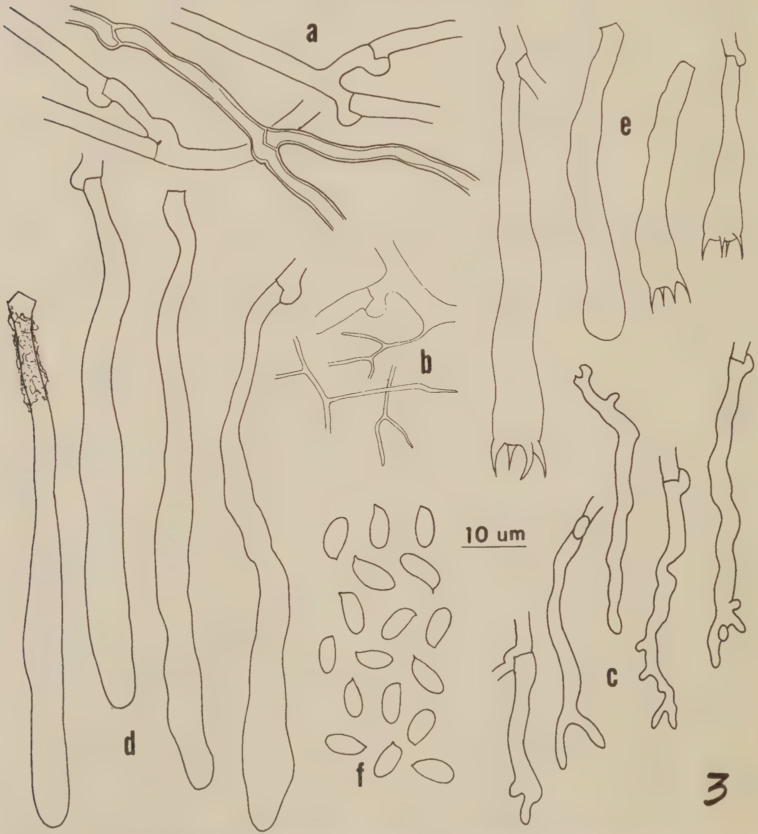


Fig. 3. Hyphoderma leoninum (HHB 4063, holotype): a. subicular hyphae, b. binding-type hyphae, c. dendrohyphidia-like structures, d. cystidia, e. basidia, f. basidiospores.

Hyphal system dimitic. *Subiculum* a *textura intricata*, hyphae 2-3 µm diam, firm-walled to thick-walled, hyaline, with frequent branching, nodose septate, surface smooth to irregularly encrusted with hyaline or pale yellow crystals, also with much branched, narrow, binding-type hyphae up to 1 mm diam, some lacking a lumen, hyaline, smooth, branched at nearly right angles; *subhymenium* a compact *textura intricata*, hyphae thin-walled, hyaline, 2-3 µm diam, smooth or occasionally encrusted with hyaline to pale yellow crystals, nodose septate, with frequent branching; *cystidia* arising in subhymenium but protruding through subsequent hymenia and appearing as pseudocystidia, clavate to nearly cylindrical or occasionally clavipedunculate, 50-100 x 6-8 µm, hyaline, thin-walled except near base where walls are sometimes thickened, nodose septate at base, contents densely staining in phloxine, unchanged in sulfuric benzaldehyde, aseptate, mostly embedded with only the apex extending above the basidia up to 10-15 µm; *dendrohyphidia-like structures* (possibly merely hyphae overgrowing the hymenium) with small apical digitate branching at apex, 30-50 x 2.5-3 µm, thin-walled, hyaline, smooth, nodose septate at base; *basidia* clavate, 30-40(-50) x 6-7.5 µm, hyaline, thin-walled, nodose septate at base, 4-sterigmate, sterigmata up to 6 µm long; *basidiospores* ellipsoid to narrowly ellipsoid, 5.5-7.5 x 2.5-3(-3.5) µm, hyaline, thin-walled, smooth, Melzer's -, acyanophilous.

Etymology: From *leoninum* (L., adj.), relating to lion, as in the color of its pelt.

Specimens examined: Holotype cited above. OHIO--W. B. Cooke 33049, on bark of rotted hardwood, Hamilton County (CFMR, MU).

Remarks: *Hyphoderma leoninum* is unique in possessing narrowly ellipsoid basidiospores and long, clavate cystidia with densely staining contents. In addition, the scattered, much branched binding-type hyphae occasionally seen are unique to *H. leoninum*. Also distinctive are its tan color and zonate margin.

Cultural description:

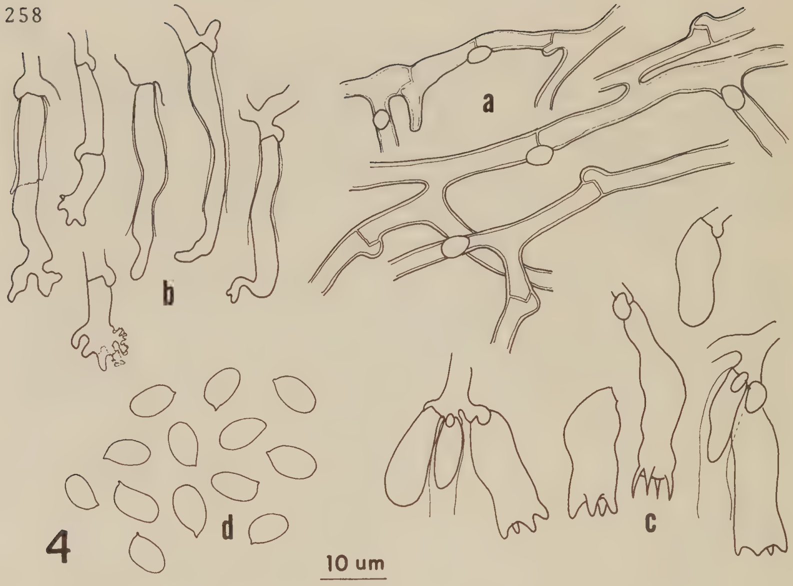
Growth characters: Growth on MEA (malt extract agar) moderate, 18-32 mm diam at 1 wk, 58-66 mm diam at 2 wk; mats white, appressed, thick, felty to woolly around inoculum, thinning out toward margins, becoming raised, woolly to cottony, tough, peels easily from agar at 2 and 4 wk, by 6 wk white, thick, thinning out toward margins, appressed, chamois-like in central part of mat, becoming slightly raised, woolly to felty, but finally appressed, subfelty in marginal zone; margins even, appressed; odor absent at 2 wk, faint, unpleasant at 4 wk; agar discoloration none; not fruiting by 6 wk. Oxidase reactions after 1 wk on GAA (gallic acid agar) and TAA (tannic acid agar) negative, stain, or strongly positive, growth none.

Microscopic characters: Advancing zone hyphae 2.5-5 µm diam, thin-walled, nodose septate, moderately branched. Submerged hyphae 1.5-6 µm diam, thin- to firm-walled, nodose septate, moderately branched. Aerial hyphae (a) 1-4 µm diam, thin-walled, nodose septate, moderately branched; (b) 0.5-1.5 µm diam, hyaline, thick-walled, aseptate, moderately to frequently branched. Cystidia globose to clavate, 6-9 µm diam, often stalked, up to 75 µm long, hyaline, thin-walled, terminal, scattered in aerial mat at 2 and 6 wk.

Culture studied: HHB 4063.

Key patterns: A-O-M-1-11-16, A-P-M-1-11-16.

Species code: 1.3.15.24.32.36.38.45-46.(53).54., 2.3.15.24.32.36.38.45-46.(53).54.



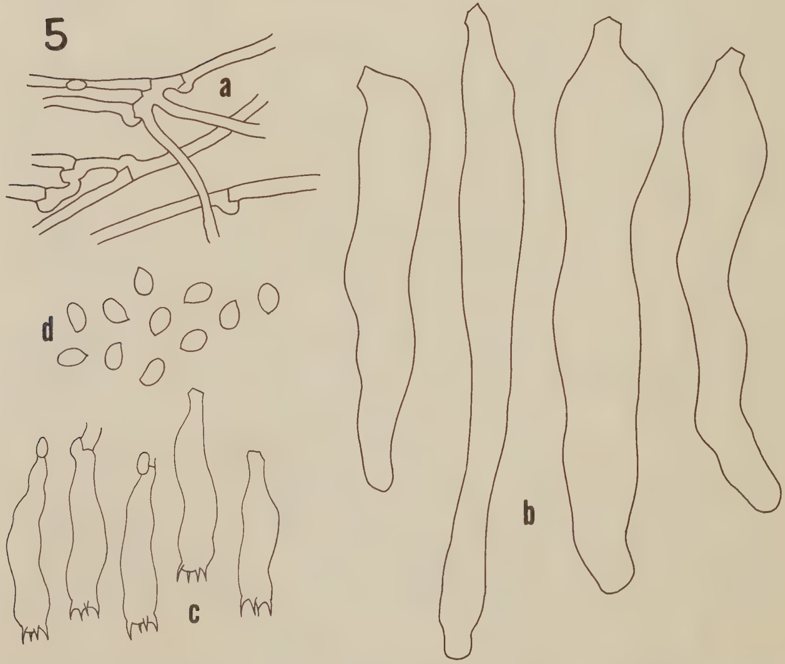


Fig. 4. Hyphoderma rimosum (HHB 6892, holotype): a. subicular hyphae, b. dendrohyphidia-like structures, c. basidia, d. basidiospores.
Fig. 5. Hypochnicium stratosum (HHB 9736, holotype): a. subicular hyphae, b. cystidia, c. basidia, d. basidiospores.

4. *HYPHODERMA RIMOSUM* Burds. et Nakas., sp. nov. Figs. 4, 6-9

Species basidiocarpis rimosis; structuris hymeniis similaribus dendrohyphidiis; basidiis breviclavatis sed parum basis inflatis; basidiosporis ellipsoideis, 6.5-8 x 3.5-4 µm congeneribus diversa.

Holotypus: HHB 6892, on *Liquidambar styraciflua* L., behind Sears, U.S. Route 441, Gainesville, Alachua County, Florida, leg. H. H. Burdsall, Jr., 6 VII 1972 (CFMR).

Basidiocarp effuse, crustaceous, thin; fertile area greyish orange (5B3-5B4) to greyish yellow (near 4B3), densely cracked into small polygons less than 1 mm diam and exposing subiculum; subiculum thin, white, fibrous; margin poorly differentiated, very thin, white, fimbriate irregular in outline.

Hyphal system monomitic. *Subiculum* a compact *textura intricata* or sometimes with agglutinated hyphae, thin-walled to firm-walled, 2-4 µm diam, hyaline, sparsely or densely encrusted with hyaline crystals, nodose septate, with regular branching; *subhymenium* a compact *textura intricata*, hyphae 2.5-3.5 µm diam, thin-walled, much contorted, nodose septate, with frequent branching; *dendrohyphidia-like structures* variable, sometimes simple but often with contorted and branched apex, 2.5-4 µm diam at base, tapering to 1.5-2.5 µm diam at apex, smooth or encrusted with hyaline crystals at apex, nodose septate at base; *basidia* nearly cylindrical or more frequently with a probasidial swelling at base, (18-)21-27(-35) x 5.5-6.5(-9) µm, hyaline, thin-walled, nodose septate at base, 4-sterigmate, sterigmata up to 6 µm long; *basidiospores* ellipsoid with an adaxial flattening, 6.5-8 x 3.5-4 µm, hyaline, thin-walled, smooth, Melzer's -, acyanophilous.

Etymology: From *rimosus* (L., adj. = full of cracks), referring to the densely cracked hymenial surface.

Specimens examined: Florida--HHB 4836, on *Quercus virginiana* L., Highlands County; HHB 6892, holotype cited above; FP 104010, on fallen hardwood branch, Duvall County. Maryland--HHB 725, on *Acer* sp., Prince Georges County; FP 104399, on fallen hardwood branch, Talbot County. Mississippi--FP 103494, on fallen hardwood branch, Harrison County; HHB 8884, on *Ilex vomitoria* Ait., Stone County; HHB 8887, on *Cornus florida* L., Stone County; HHB 8895, on *Lagerstroemia indica* L., Harrison County.

Remarks: *Hyphoderma rimosum* is unique among *Hyphoderma* species in possessing densely cracked, crustaceous basidiocarps with the white subiculum exposed in the cracks. It is also distinctive microscopically in possessing dendrohyphidia-like structures sometimes encrusted in the apex and, in some specimens, pronounced probasidial swelling. *Hyphoderma rimosum* is associated with a white rot of dead and fallen hardwood branches. It appears to be restricted to the East Coast and the southeastern United States.

Cultural description:

Growth characters: Growth on MEA moderate, (45-)60-80 mm diam at 2 wk; mats white, zonate or not, around inoculum appressed to slightly raised, silky or woolly, becoming raised, silky to woolly toward margins, overall aspect of mat is that of numerous hyphal strands overlapping and intersecting, distinct near inoculum, but becoming blurred toward margins at 2 wk, by 6 wk mats firm, marginal areas appressed to raised, woolly to felty, usually forming short, aerial tufts of mycelium scattered over mat or against the petri plate sides, these tufts composed of a slender stalk that usually expands at the apex; margins even, dense, appressed to slightly raised; odor none;

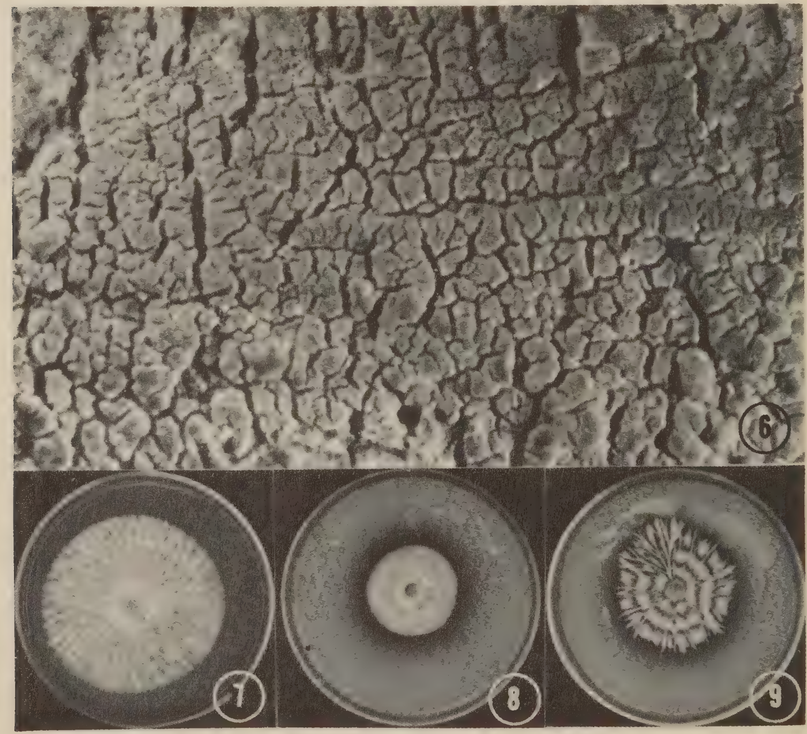
agar discoloration none; not fruiting by 6 wk. Oxidase reactions after 1 wk on GAA strong, mat 0-trace, on TAA strong, mat 12-24 mm diam.

Microscopic characters: Advancing zone hyphae 2-4 µm diam, thin-walled, nodose septate, sparingly branched. Submerged hyphae 1.5-5(-6) µm diam, thin- to firm-walled, nodose septate, moderately branched, in 2 wk-old cultures larger hyphae predominate, by 6 wk consisting primarily of richly branched hyphae 1.5 µm diam, thin- to firm-walled, nodose septate. Aerial hyphae similar to submerged hyphae except encrusted with tiny, hyaline crystals at 2 wk that sometimes develop into a crystalline sheath by 6 wk, and also with large, coarse crystals scattered in aerial mat.

Cultures studied: HHB 725, HHB 4836, HHB 6392, HHB 8884, HHB 8887, HHB 8895, FP 103494.

Key pattern: A-P-M-1-10-16, A-P-M-1-10. Species code: 2.3.7. 32.36.38.45-47.54.

Remarks: The outstanding feature of this fungus in culture is the texture of the mats on MEA and TAA. The TAA mat at 2 wk is (a) white, raised, cottony, with a few short cordons developing from



Figs. 6-9 Hyphoderma rimosum. Fig. 6. Basidiocarp surface (HHB 6892) X 5. Fig. 7. Two week-old culture mat, HHB 8887 on MEA. Fig. 8. Two week-old culture mat, HHB 8895 on TAA. Fig. 9. Two week-old culture mat, HHB 8884 on TAA.

inoculum, or (b) white to yellowish white (4B2), appressed, with numerous hyphal strands developing from inoculum and spreading out in fanlike pattern, occasionally developing short aerial tufts of mycelium. Although similar in culture to some species of Naematoloma, which develop yellow-brown mats on MEA, MEA mats of H. rimosum always remain white.

5. HYPOCHNICIUM STRATOSUM Burds. et Nakas., sp. nov. Fig. 5

Basidiocarpis stratosis, crassis; cystidiis obclavatis, laevibus, 60-100 x 9-12(-20) µm; basidiosporis ellipsoideis, 4-5.5 x 2.5-3.5 µm.

Holotypus: HHB 9736, on Fagus grandifolia Ehrh., Woodyard Hammock, Tall Timbers Research Station, Leon County, Florida, leg. H. H. Burdsall, Jr., 2 VIII 1977 (CFMR).

Basidiocarp annual, broadly effuse, up to 1 mm thick, crustaceous; fertile area yellowish white (near 3A2), smooth at first, becoming rimose in age, with subiculum showing through cracks; margin very narrow, fimbriate, white, irregular in outline; subiculum concolorous with fertile area, fibrous, appearing layered when viewed in longitudinal section.

Hyphal system monomitic. Subiculum very thin and difficult to observe, distinct hyphae found only at margin, hyphae 2-3 µm diam, thin-walled, hyaline, smooth, nodose septate, frequently branched, with some very fine, much branched hyphae up to 1 µm diam arising laterally from these hyphae, aseptate, smooth; subhymenium composing most of basidiocarp, up to 1 mm thick, both spores and cystidia embedded in the tissue, hyphae not distinguishable; cystidia arising in subhymenium but embedded by overgrowth of later-developed hymenia, obclavate to nearly cylindrical, 60-100 µm long, 9-12 µm wide near apex, swollen up to 20 µm wide near basal septum, thin- to firm-walled, smooth, nodose septate at base, not reacting with sulfuric benzaldehyde, older cystidia sometimes with contents becoming brownish yellow and refractive, some protruding up to 20 µm above basidia apices; basidia clavate but often with a median swelling, 24-30 x 5-5.5 µm, hyaline, thin-walled, nodose septate at base, 4-sterigmate, sterigmata up to 3 µm long; basidiospores ellipsoid, adaxially flattened, 4-5.5 x 2.5-3.5 µm, hyaline or with a pale yellow tint, thick-walled, smooth, Melzer's -, acyanophilous.

Etymology: From stratosum (L., adj. = in layers), because of the layered appearance of the basidiocarp in cross section.

Specimen examined: Holotype cited above.

Remarks: The presence of thick-walled basidiospores is the primary character used in deciding on Hypochnicium as the generic placement for H. stratosum. The basidiocarp construction, the presence of the long flexuous cystidia, and the compact, thick fruiting body are reminiscent of the genus Gloeocystidiellum, but the nonamyloid basidiospores argue against that generic disposition.

6. PENIOPHORA SPHAEROCYSTIDIATA Burds. et Nakas., sp. nov. Figs. 10,13-14

Differt a species Peniophora dendrohyphidiis, pseudocystidiis sphaericis vel subsphaericis, inclusis, 40-50 µm latis, parietibus crassis; basidiosporis ellipsoideis, 5-6.5(-8) x 3-3.5(-4) µm.

Holotypus: HHB 8827, on Vaccinium sp., Harrison Experimental Forest, Road H 2, De Soto National Forest, Harrison County, Mississippi, leg. H. H. Burdsall, Jr., 26 III 1976 (CFMR).

Basidiocarp annual, effuse in small patches, coalescing and broadly effuse on smaller branches, up to 0.1 mm thick, crustaceous, adherent, with some cracking; fertile areas continuous, smooth, yellowish white (4A2) to greyish yellow (4B4); margin abrupt, white or concolorous with fertile area; subiculum compact, white, extremely thin.

Hyphal system monomitic. Subiculum a textura intricata, hyphae somewhat contorted, 2-4 µm diam, firm-walled, hyaline, with frequent branching, nodose septate, smooth; subhymenium a textura intricata, hyphae thin-walled, 2-4 µm diam, hyaline, smooth, nodose septate, with frequent branching; dendrohyphidia densely branched at apex, 25-30 x 3-5 µm, thin-walled, hyaline, encrusted on fingerlike branches, nodose septate at base; pseudocystidia broadly ovoid to globose, 25-40 x 25-50 µm, thick-walled (walls up to 3 µm thick), smooth, embedded in subiculum nearly on the substrate surface, smooth, turning dark blue black in sulfuric benzaldehyde, cystidia subulate, 25-30 x 5-6 µm, hyaline, thin-walled, smooth, protruding to just beyond basidia; basidia cylindrical with a basal or nearly basal swelling, 24-35 x 5-6 µm, thin-walled, hyaline, nodose septate at base, 4-sterigmate, sterigmata up to 6 µm long; basidiospores narrowly ovoid, adaxially depressed, 5-6.5(-8) x 3-3.5(-4) µm, hyaline, thin-walled, smooth, Melzer's -, acyanophilous.

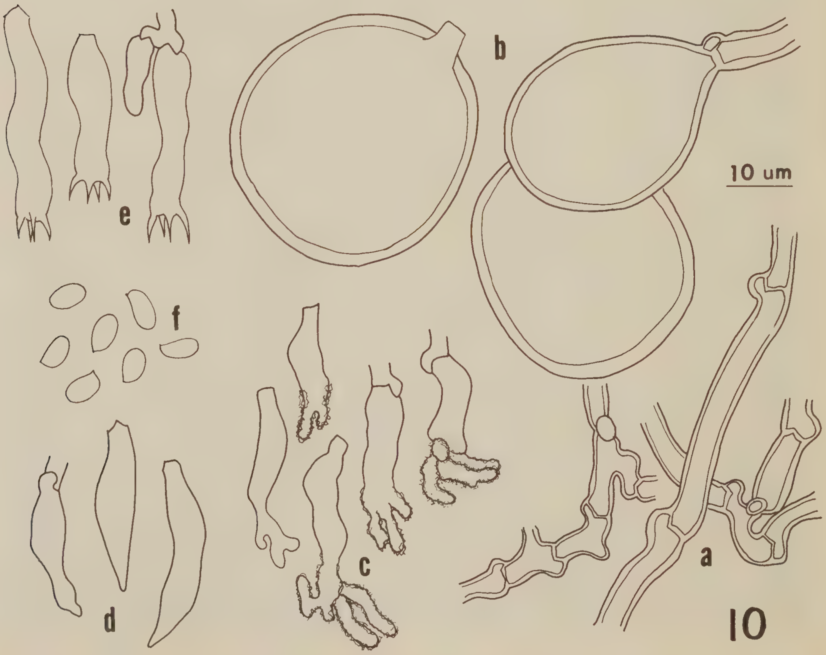


Fig. 10. Peniophora sphaerocystidiata (HHB 8827, holotype): a. subicular hyphae, b. pseudocystidia, c. dendrohyphidia, d. cystidia, e. basidia, f. basidiospores.

Specimen examined: Holotype cited above.

Remarks: Peniophora sphaerocystidiata is unique among the Peniophora species that possess dendrohyphidia in that it also possesses hymenial cystidia and large, ovoid to spherical pseudocystidia embedded in the subiculum.

Cultural description:

Growth characters: Growth on MEA moderately rapid, 53-59 mm diam at 1 wk, plates covered (90+ mm diam) at 2 wk; mats white, appressed, thin, subfelty around inoculum, becoming raised, moderately thick, cottony to woolly toward margins at 2 wk, by 4 and 6 wk white, appressed, thin, subfelty throughout, with scattered small or large patches of denser, tougher, felty mycelium, growing vigorously up plate sides, this mycelium white to brownish orange (near 5C6) or brown (6E5); margins even, raised; odor sweet, fruity at 2 and 4 wk; agar discoloration none at 2 wk, greyish orange (near 5B5) to brownish orange (near 5C6) at 4 and 6 wk; not fruiting by 6 wk. Oxidase reactions after 1 wk on GAA strong, mat trace-14 mm diam, on TAA strong, mat 36-37 mm diam.

Microscopic characters: Advancing zone hyphae 3.5-6 µm diam, thin-walled, long-celled, nodose septate, sparingly branched. Submerged hyphae 1-7 µm diam, thin-walled, larger hyphae firm-walled, nodose septate, moderately branched. Aerial hyphae similar to submerged hyphae except hyphal segments heavily encrusted with hyaline crystals, by 4 wk hyphae of felty areas firm-walled to thick-walled, often agglutinated. Pseudocystidia variously shaped, globose to clavate or cylindrical, 2-10 µm diam, hyaline, thin-walled, terminal or intercalary, filled with pale yellow, refractive, oil-like material, numerous in aerial mat at 2 and 6 wk.

Culture studied: HHB 8827.

Key pattern: A-P-I-1-10-14-16. Species code: 2.3.15.32.36.37.(38).39.43.50.54.

7. STECCHERICIUM SERIATUM (Lloyd) Maas G., Fig. 11
Proc. K. Ned. Akad. Wetens. Ser. C 69:325. 1966.
= Steccherinum westii Murr., Bull. Torrey Bot. Cl. 67:276. 1940.
≡ Hydnum westii (Murr.) Murr., Bull. Torrey Bot. Cl. 67:281. 1940.

Basidiocarp annual, effuse to effuse-reflexed, reflexed portion up to 6 mm wide, imbricate, pileus surface villous to nearly glabrous in older areas, nearly white but with creamy tint; margin up to 1 mm thick; fertile area hydnaceous, greyish orange (5B3), teeth up to 2 mm long, slender, context up to 2 mm thick, nearly white with cream tint.

Hyphal system dimitic. Subiculum a textura intricata, generative hyphae 3-5.5 µm diam, thick-walled, walls up 1.5 µm thick, hyaline, nodose septate, much branched, usually branching at or very near clamp connection, smooth, also with gloeopleurous hyphae widely scattered through context, thin- to thick-walled, with densely granular to globular contents, not staining in sulfuric benzaldehyde; tooth trama a textura porrecta, hyphae like those of subiculum but with hyphae mainly of the gloeopleurous type, up to 10 µm wide, apices of these hyphae frequently turning and protruding into the hymenium, at tooth apex a profusion of hyphae 2-3 µm broad, thin-walled, nodose septate; hymenium penetrated by numerous pseudocystidia from the gloeopleurous hyphal system, these up to 10 µm diam, thin-walled, hyaline, irregularly swollen and constricted, sometimes with an apical bead, smooth, contents not reacting in sulfuric benzaldehyde; basidia clavate, 12-15(-20) x 3-4 µm, hyaline, thin-walled, nodose septate at base, 4-sterigmate, sterigmata up to 3.5 µm long; basidiospores ellipsoid, 3-4 x 2-2.5 µm, with finely granulose surface, firm- walled, with slight yellow tint, amyloid, acyanophilous.

Specimens examined: Florida--HHB 9499, on Quercus sp., Tall Timbers Research Station, Leon County; F 8421, on hardwood, Hawthorne, and F 18006 (Holotype), on Quercus sp., Newnan's Lake, Alachua County, both as H. westii (FLAS).

Remarks: The characters of this species indicate its close relationship to the members of the genus Hericium. It possesses the thick-walled hyphae, a gloeopleurous hyphal system not reacting with sulfuric benzaldehyde, and the small, oval, amyloid, roughened basidiospores characteristic of that group. It belongs in the family Hericiaceae.

Maas Geesteranus and Lanquetin (1975) described Steccherícium seriatum in culture, reporting it to be tetrapolar. Our matings of singled-spored isolates of HHB 9499 confirmed those results: A_1B_1 = 1,2,3,6,8,13,19; A_2B_2 = 7,16; A_1B_2 = 4,9,20; A_2B_1 = 5,15,18,22.

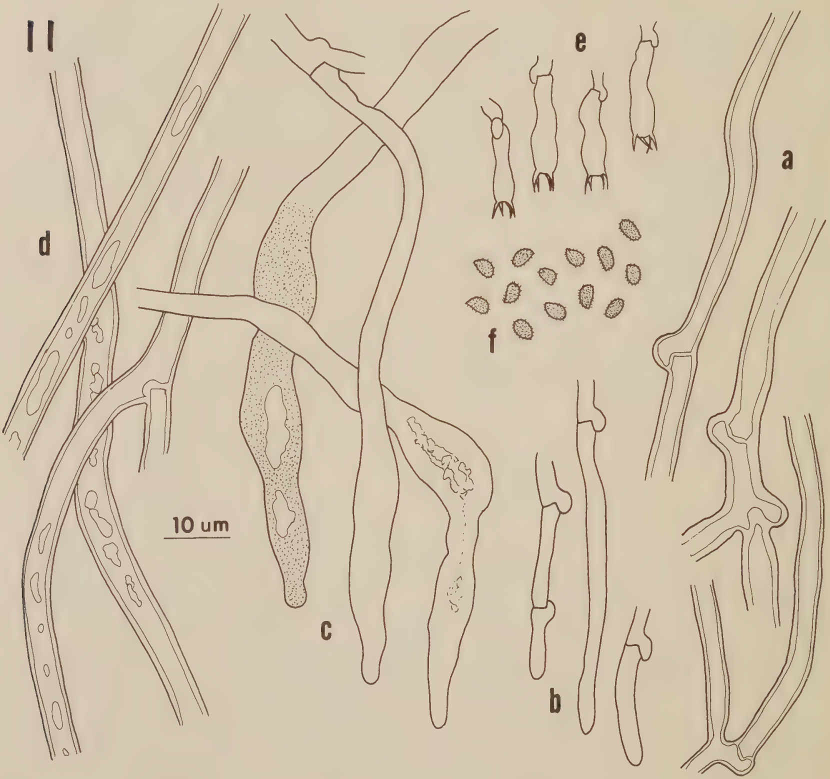


Fig. 11. Steccherícium seriatum (HHB 9499): a. subicular hyphae, b. hyphae from tooth apex, c. pseudocystidia, d. gloeopleurous hyphae, e. basidia, f. basidiospores.

8. TUBULICIUM CAPITATUM (D. P. Rogers et Boquiren)
Burds. et Nakas., comb. nov. Figs. 12, 15-17
≡ Epithele capitata D. P. Rogers et Boquiren in Boquiren, Mycologia 63:942. 1971.

Basidiocarp annual, broadly effuse, up to 0.2 mm thick, pruinose to pubescent, adherent; fertile areas continuous, pubescent to hispid, yellowish white (4A2); margin up to 1 mm broad, very thin, pubescent, irregular in outline, concolorous with the fertile area; subiculum fibrous, concolorous with the fertile area, up to 100 µm thick.

Hyphal system monomitic. Subiculum a textura intricata, hyphae indistinct, 2-2.5 µm diam, thin-walled, hyaline, frequently branched, nodose septate, smooth; subhymenium indistinct, hyphae like those of subiculum; pseudocystidia scattered throughout the subiculum and sub-

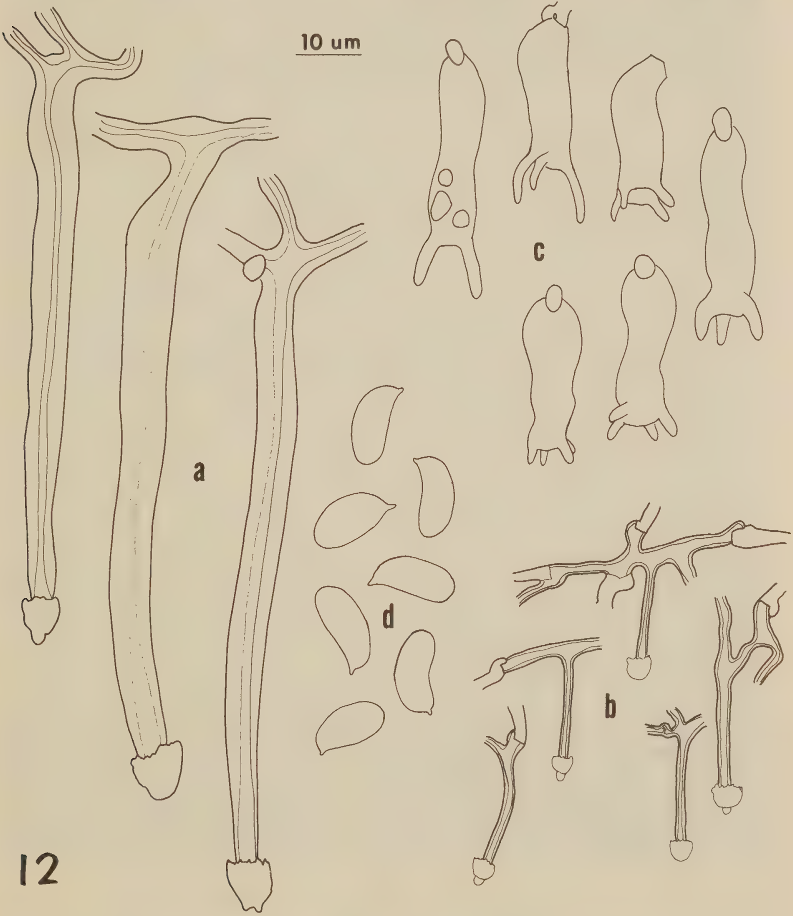
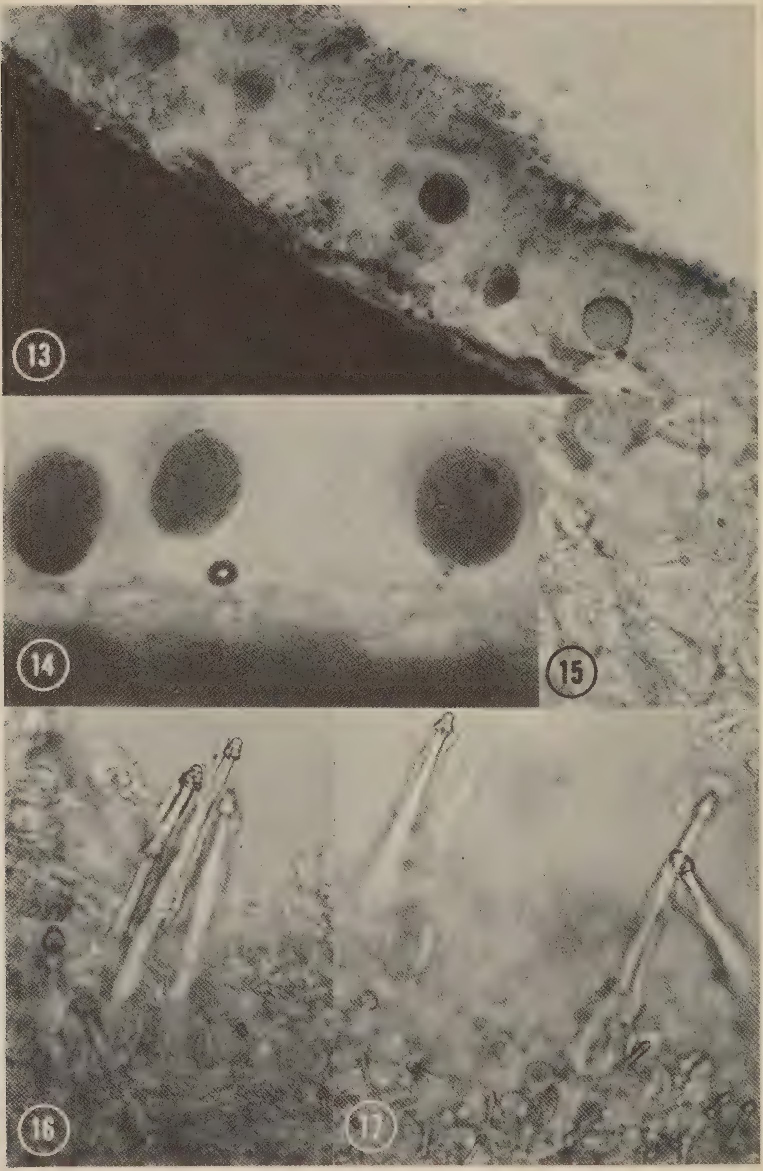


Fig. 12. Tubulicium capitatum (HHB 6714): a. large pseudocystidia, b. small pseudocystidia, c. basidia, d. basidiospores.



Figs. 13-17. Photomicrographs of *Peniophora sphaerocystidiata* (HHB 8827) and *Tubulicium capitatum* (HHB 6714).
Figs. 13-14. *Peniophora sphaerocystidiata*, sphaerocystidia in cross section mounted in sulfuric benzaldehyde. 13. X 200. 14. X 350.
Figs. 15-17. *Tubulicium capitatum*, capitately encrusted pseudocystidia of various sizes. X 350.

hymenium in no particular arrangement, cylindrical to nearly subulate, 18-120 x 1-9 µm, with a crystalline collar near the apex, the largest protruding through the hymenium, walls up to 4 µm thick, smooth, hyaline or yellow, with one or several roots, clamped at base, enveloped by several indistinct, hyaline hyphae, 1-2 µm diam; *basidia* utriform, constricted below apex and with a swollen base, 21-25(-30) x 5.5-8 µm, thin-walled, hyaline, nodose septate, 4-sterigmate, sterigmata digitate, up to 12 µm long; *basidiospores* narrowly ellipsoid to broadly allantoid, 11-13 x 5-6.5 µm, hyaline, thin-walled, smooth, Melzer's -, acyanophilous.

Specimens examined: Florida--R. Singer (F 832), on *Phoenix canariensis* Chaub., holotype of *E. capitata*, Dade County (ILL); HHB 6714, on *Sabal palmetto* (Walt.) Lodd. in J. A. et J. H. Schult., Marion County (CFMR).

Remarks: This report of *T. capitatum* is only the second collection we know of. When Rogers and Boquiren described the species (Boquiren 1971), they did not clearly specify that the capitate pseudocystidia vary so greatly in size and are distributed throughout the entire basidiocarp.

Tubulicium capitatum has pseudocystidia similar to those found in *Tubulicrinus hamatus* (Jacks.) Donk and *Tubulicrinis corneri* Jülich. However, the cystidia in *Tubulicium capitatum* do not dissolve in 10% KOH as they do in the *Tubulicrinis* species. There is also the possibility of confusing *Tubulicium capitatum* with *Xenasma macrospora* Liberta, but in the latter species the cystidia are at least twice as large and do not have the capitate encrustations found in the former.

The generic name *Tubulicium* Oberw. (1965) is a problem because of the nearly simultaneous publication of *Tubulixenasma* Parm. (1965). *Tubulicium* was published in June 1965, according to the front page of the journal. *Tubulixenasma* was published either in May 1965 (fide Index of Fungi 3(16):473. 1968), June 21, 1965 (Parmasto, 1968), or in July 1965, (fide Index of Fungi 3(20):568. 1970). We are accepting July 1965 as the publication date for *Tubulixenasma*. However, if Parmasto (1968) is correct in his citation (21 June 1965), and then *Tubulixenasma* must take priority.

Jülich (1981) erected the family *Litschauerellaceae* for *Litschauerella* Oberw. but excluded *Tubulicium* despite the fact that Jülich and Stalpers (1980) declared *Litschauerella* and *Tubulicium* to be synonymous. We support the latter contention and not the former. Unfortunately, Oberwinkler (1965) published no valid combinations when he proposed the generic name *Tubulicium*. All combinations lacked complete citation for the basionym. Jülich (1979) validated these combinations later.

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CULTURAL AND MORPHOLOGICAL STUDIES ON CYSTOSTEREUM AUSTRALE (CORTICIACEAE), A NEW SPECIES FROM SOUTHEASTERN U.S.A. AND COSTA RICA

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SUMMARY

Cystostereum australe, a new species from southeastern U.S.A. and Costa Rica, is reported. It is closely related to *Cystostereum murraii*, a common and widely distributed wood decay fungus. The basidiocarp and cultural characteristics of the new species are described, illustrated, and compared with *C. murraii*. The two species can be differentiated by basidiospore morphology and cultural characters.

INTRODUCTION

Cystostereum murraii (Berk. et Curt.) Pouz. is a common and well-known wood decay fungus in North America (Burt, 1920; Lentz, 1955). It is also described from Europe (Eriksson and Ryvarden, 1975), South Africa (Talbot, 1954), India and Nepal (Rattan, 1977), and New Zealand (Cunningham, 1963). During a cultural study of *C. murraii*, I discovered a closely related but undescribed species. Although the two species are very similar in gross morphology of basidiocarps and cultures, significant differences in basidiospore shape and cultural characteristics are apparent. Data supporting the separation of the two taxa are presented.

Materials and methods used are described in Nakasone (1982). Capitalized color names are from Ridgway (1912) and herbarium abbreviations from Holmgren *et al*. (1981). In addition, Boidin's (1951, 1958) media formulation, with some modification, was used to test for the presence of tyrosinase. Tyrosine agar (TyA) was made by adding 15 gm agar, 5 gm malt extract, and 2 gm L-tyrosine to 1,000 ml distilled water and then autoclaving for 15 minutes at 15 psi. The centrally inoculated plates were kept in the dark at 25 C and examined at 1 and 2 wk. Any color change (a black discoloration of the medium indicates the presence of tyrosinase) and mycelial growth was recorded.

[1/] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

BASIDIOCARP AND CULTURE DESCRIPTIONS

Cystostereum australe Nakasone, sp. nov. Fig. 1, A-H

Differt a C. murraii cystidiis paraphysoideis 15-35 x 1-4.5 µm, basidiosporis 5.5(-6) x 3.5-4 µm, ellipsoideis, hyalinis. In culturis condidiis (chlamydosporis) intercalaribus crassis tunicatis, thalliciis in origine, 12-35 x 8-12 µm. Holotypus - FP 105668 ad lignum Quercuum sp., proxime Bainbridge, Georgia, U.S.A., Legit Davidson, Campbell, Aoshima, et Driver, 15 IV 1961 (in herb. CFMR).

Basidiocarps perennial, adnate, effused up to 12 x 5 cm, sometimes narrowly reflexed, up to 2.5 mm thick, ligneous, when dried often deeply cracked, with black zone lines between fruit body and substrate. Fertile areas continuous, surface smooth to tuberculate, Cream Color to Pale Cream-Buff or Ivory Yellow, turning dark brown (Bone Brown) to black in 2% KOH. Margins abrupt, narrow, effused or narrowly reflexed, often pulling away from the substrate when dried, irregular in outline, concolorous with hymenium. Subiculum hard, ligneous, light brown, exposed between deep cracks.

Hyphal system dimitic. Subiculum up to 120 µm thick, composed of (a) generative hyphae 2-4 µm diam, hyaline, thin- to slightly thick-walled, nodose septate, smooth, moderately branched, parallel to substrate, these seen only in thin, young developing parts of basidiocarp especially the margins and often completely obliterated in mature specimens; (b) skeletal hyphae 0.5-1.5 µm diam, hyaline, thick-walled, aseptate, frequently branched, smooth, numerous in subiculum and substrate. Subhymenial trama thickening, up to 2.3 mm thick, composing most of basidiocarp, consisting of generative hyphae vertically arranged in a dense, agglutinated mass, with some skeletal hyphae and numerous, stratified cystidia. Hyphidia slender, more or less cylindrical, tapering toward apex, 15-35 x 1-4.5 µm, hyaline, thin-walled, clamped at base, smooth, rarely protuding beyond hymenium. Cystidia clavate to ventricose, 25-45(-60) x 9-14(-18) µm, hyaline, slightly thick-walled, clamped at base, smooth, usually embedded, rarely protruding up to 40 µm beyond hymenium, negative in sulfobenzaldehyde, those in subhymenial trama often filled with homogenous, refractive yellow contents, numerous throughout subhymenium and hymenium. Basidia clavate, 25-42 x 5.5-7 µm, hyaline, thin-walled, clamped at base, 4-sterigmate, sterigmata up to 3 µm long. Basidiospores ellipsoid, flattened adaxially, 5.5(-6) x 3.5-4 µm, hyaline, slightly thick-walled, smooth, negative in Melzer's reagent, staining strongly in cotton blue.

Culture description--Growth characters: Growth on malt extract agar slow, 21-27(-45) mm diam at 2 wk; mats white, raised cottony to velvety at 2 wk, by 6 wk white, raised, downy to cottony; margins even, raised, dense; odor none; agar discoloration none; not fruiting by 6 wk. Oxidase reactions after 1 wk on gallic acid agar stain or strongly positive, growth 0-trace, on tannic acid agar strongly positive, growth trace-14 mm diam. On TyA reaction negative, trace of growth at 1 wk.

Microscopic characters: Advancing zone hyphae 2.5-3 µm diam, thin-walled, nodose septate, sparingly to moderately branched. Submerged hyphae 1-4 µm diam, similar to advancing zone hyphae.

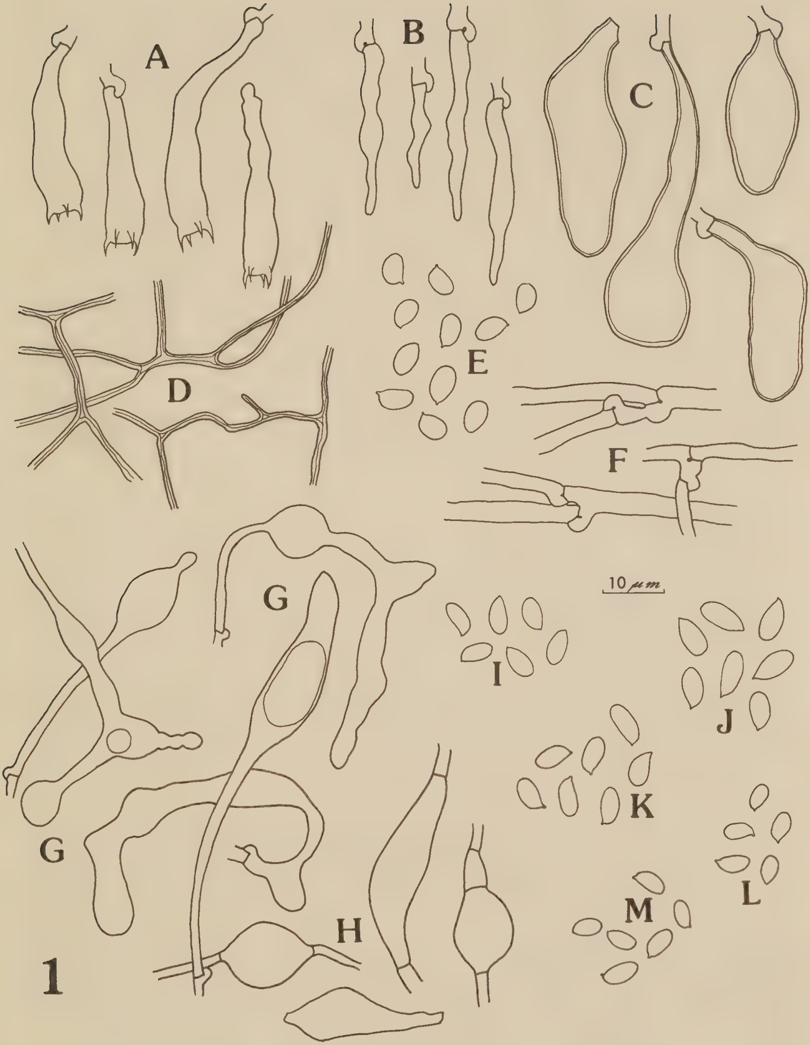

Figure 1. A-F. Microscopic characters from C. australe basidiocarp (FP 105668, holotype). A. basidia; B. hyphidia; C. ventricose cystidia; D. skeletal hyphae; E. basidiospores; F. subicular hyphae.

G-H. Microscopic characters from cultures of C. australe (FP 105668). G. vegetative cystidia (gloeocystidia); H. chlamydospores.

I-M. Basidiospores of C. murraii. I. from FP 101121; J. from Wright 269 (holotype of Thelephora murraii); K. from holotype of Stereum pulverulentum; L. from holotype of Corticium effusum; M. from holotype of Stereum tuberculosum.

Aerial hyphae (a) similar to submerged hyphae; (b) fiber hyphae 0.5-1.5 µm diam, thick-walled, hyaline, aseptate, usually branched at right angles, present only in JLL 12913 at 2 and 6 wk. Cystidia (gloeocystidia) variably shaped, stalked clavate to irregularly cylindrical, up to 100 x 2-10 µm, thin-walled, terminal or lateral, often lobed or curved, with opaque oil-like material which often fills entire structure, numerous in aerial mat at 2 wk. Chlamydospores limoniform to fusiform, 12-35 x 8-12 µm, thin-walled, hyaline, intercalary, thallic in origin, abundant in submerged and aerial mats at 2 and 6 wk.

Key Patterns: A-P-S-1-2-10-16; A-P-S-1-2-11-16 (format from Davidson *et al*., 1942). Species Code: 2.3.(8).15.34.36.38.47.54 (format from Nobles, 1965).

Specimens and cultures studied: COSTA RICA--J. L. Lowe 12913 on bark of dead hardwood, Birri, Heredia Province (CFMR). U.S.A.--H. H. Burdsall 6648 on *Ulmus* sp., Devil's Millhopper, and FP 103021 on *Carya* sp., Gainesville, Alachua County, Florida (CFMR); FP 105668, holotype cited above.

Remarks: *Cystostereum australe* is associated with a white rot decay of hardwoods. It is apparently a rare species and has been collected in Florida, Georgia, and Costa Rica.

Cystostereum murraii (Berk. et Curt.) Pouz., Fig. 1, I-M
Ceská Mykol. 13:18. 1959.
≡ *Thelephora murraii* Berk. et Curt., J. Linn. Soc. Bot. 10:329. 1869.
= *Stereum tuberculosum* Fr., Hymen. Eur. p. 644. 1874.
= *Stereum pulverulentum* Peck, Bull. Torrey Bot. Club 27:20. 1900.
= *Corticium effusum* Overh., Mycologia 22:238. 1930.

For basidiocarp descriptions of this species see Eriksson and Ryvarden (1975), Lentz (1955), or Lindsey and Gilbertson (1978). The synonymy of *C. murraii* has been treated by Rogers and Jackson (1943), Lentz (1955), and Jülich and Stalpers (1980).

Specimens examined: CUBA--*T. murraii*, C. Wright 269 (FH, isotype). NORWAY--*S. tuberculosum*, on bark (UPS, holotype). U.S.A.--*S. pulverulentum*, on bark of *Betula papyrifera* Marsh., Orono, Maine, F. L. Harvey, October 1898 (NYS, holotype); *C. effusum*, on *Acer* sp., Ferdinand, Vermont, Spaulding. October 1, 1926, FP 43963, L. O. Overholts Herb. 11324 (PAC, holotype); FP 101121, on bark of *B. papyrifera*, Oneida County, Wisconsin.

Culture description--Culture descriptions of *C. murraii* can be found in Davidson *et al*. (1941), Nobles (1948), Boidin (1958), and Stalpers (1978). Cultural characters of *C. murraii* are nearly identical to those of *C. australe* except that the former species has a strong, distinctive, musty odor, lacks chlamydospores, and usually but not always discolors TyA media pink within 1 wk.

Cultures studied: U.S.A.--Michigan: HHB 7670, on *Populus tremuloides* Michx.; Minnesota: RLG 9637, on *B. papyrifera*; New York: JLL 15675, on *B. alleghaniensis* Britton; Wisconsin: FP 101121, on *B. papyrifera*.

Remarks: After examining the type specimen of *S. tuberculosum* which consists of four pieces, I agree with Lentz's (1955) observations.

Table 1.--Critical characters differentiating Cystostereum australe and C. murraii

Characters	Species	
	C. australe	C. murraii
From Basidiocarp		
Basidiospore size	5.5(-6) x 3.5-4	(5-)6-7 x 3-3.5
shape	ellipsoid	cylindrical
length/width	1.5/1	1.9/1
Hyphidia	scattered	none
From Culture		
Chlamydospores	numerous	none
Reaction on TyA	yellow or negative	pink, sometimes negative
Odor	none	strong, musty

He noted that while the large fruit body was C. murraii, the three smaller pieces were specimens of Amylostereum chailettii (Pers.) Boidin. The type of Corticium effusum is fairly thin and appears to be a young form of C. murraii.

Cystostereum murraii is associated with a white rot decay of dead hardwoods and conifers. In North America it is very common on hardwoods and rare on conifers, while in Europe it is found exclusively on conifers. It is also associated with heartrot and cankers of several hardwood tree species in the U.S.A. (Davidson et al., 1941).

DISCUSSION

Cystostereum murraii and C. australe have many characteristics in common, and therefore are difficult to distinguish from each other. Table 1 summarizes those characteristics that differentiate the two species. The basidiospores of C. murraii are more cylindrical in shape than those of C. australe which are consistently ellipsoid. In culture, C. australe produces numerous chlamydospores while C. murraii produces none. The cosmopolitan nature and abundance of C. murraii contrast with the restricted distribution and rarity of C. australe.

ACKNOWLEDGMENTS

The following herbaria loaned specimens for this study: Institute of Systematic Botany, University of Sweden, Uppsala, Sweden; Farlow Library and Herbarium of Cryptogamic Botany, Harvard University, Cambridge, Massachusetts; New York State Museum, Albany, New York; Pennsylvania State University, University Park, Pennsylvania. M. J. Larsen of the Forest Products Laboratory assisted with the Latin diagnosis. Larsen and J. P. Lindsey of Fort Lewis College, Durango, Colo., reviewed the manuscript.

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CULTURAL STUDIES OF RESUPINATE POLYPORES[1]

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SUMMARY

Cultural features are given for eight resupinate subtropical or tropical polypores from South America, namely : *Ceriporia mellea, C. spissa, Grammothele subargentea, Junghuhnia microspora, Megasporoporia hexagonoides, M. setulosa, Skeletocutis nivea* var. *diluta* and *Tinctoporellus epimiltinus*. *C. spissa* and *G. subargentea* are new combinations. Arguments are given to support the inclusion of *C. spissa* among the true polypores. The affinities of *T. epimiltinus* are given.

During a survey of the resupinate polypores from Argentina (Rajchenberg, 1982) cultures were made of several little known polypores. The descriptions of the cultural features for eight species are presented. None of these species have been previously described from culture.

MATERIAL AND METHODS

All dikaryotic cultures were obtained from basidiocarp tissue. Cultures were grown, studied and described according to Nobles (1948), the plates maintained in the dark at 25 °C. Presence of oxidases was determined in 0,5% (w/v) gallic acid agar (GAA) and 0,5% (w/v) tannic acid agar (TAA) (Davidson et al., 1938:684). Presence of tyrosinase was determined on 0,2% (w/v) tyrosine agar (TyA) and 1% (v/v) p-cresol agar (pCA) (Boidin, 1958:39). Quality of reactions was recorded as given by Davidson et al. (op. cit.) followed by mycelium growth given in mm. Alcohol solution (96°) of 16,6% (w/v) gum guaiac (GG) was directly used on mycelial mats to determine rapidly the presence of oxidases in culture (Nobles, 1958), and its presence or absence recorded as + or - respectively. Line drawings of microscopic characters were made with a Wild drawing tube and photographs were taken of four week old cul-

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[2] Fellow of the above Consejo.

tures. Species codes describing 6 week old cultures are based on the system of Nobles (1965) with the modifications proposed by Boidin (1966:6). Color notations were made in accordance with Maerz & Paul (1930).

Cultures are deposited in the Laboratorio de Micología at the author's address (BAFC cultures). Fruibodies from which cultures were obtained are deposited at BAFC. All herbarium abbreviations are from Holmgren & Keuken (1974). Type materials studied are indicated by '¡'.

CULTURAL STUDIES

CERIPORIA MELLEA (Berk. & Br.)Ryv. (Figs. 1-4, 46)

Bull. Jard. Bot. Nat. Belg. 48:98, 1978.

Fruitbody description of this species was given by Ryvarden & Johansen (1980:272).

CULTURE STUDIED: n°807: Argentina, Misiones, Nat'l Park Cataratas del Iguazú, road to Apepú, leg. L. Ryvarden, 4.III.82 =BAFC 28213.

GROWTH CHARACTERS: growth very rapid, covering the plate in the first wk. Mats cream, developing light yellowish zones (Chrome Lemon 9 K 2) from the 3rd wk on; at first subfelty, becoming irregularly felty or subfelty, mycelium not abundant (Fig. 46). Odor none. Reverse bleaching, with yellowish spots. Oxidases reactions in GAA: + , 0 ; in TAA: +++ , 50 ; in TyA: - , 30 ; in pCA: - , 0 ; with GG: + .

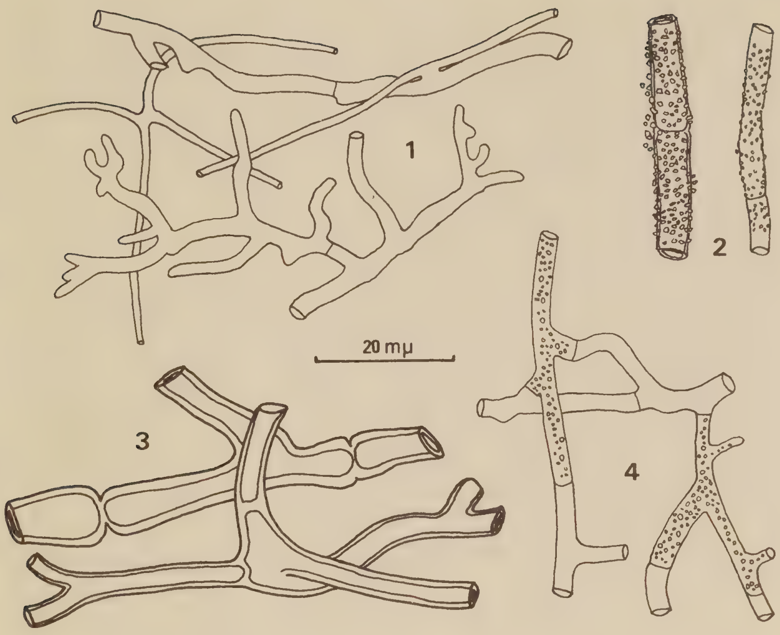
MICROSCOPIC CHARACTERS: Aerial mats formed by simple septate generative hyphae, much branched, 1.6-6.2 µm wide, at first thin-walled and few with incrustations (Fig. 1); later in the study incrustations with small polyhedric crystals increase (Fig. 2). Submerged hyphae are similar but never incrusted and there appear simple septate branched and wide generative hyphae, up to 7.8 µm wide, sclerified, with 1.0-3.1 µm wide thick walls, which increase in number with age (Fig. 3). In the 3rd wk there appear simple septate thin-walled and branched generative hyphae which lack cytoplasm but have yellowish guttulae responsible of mat coloration (Fig. 4).

SPECIES CODE: 2a. 6. 7. 32. 36. 40. 41. 54.

CERIPORIA SPISSA (Schw. ex Fr.) comb. nov. (Figs. 5-8, 47)

Basionym: *Polyporus spissus* Schw. ex Fr., Elench. Fung. p. 111, 1828.

This taxon has been interpreted as merulioid, and combinations in the genera *Caloporus* Karst. and its later synonym *Meruliopsis* Bond. & Sing. ex Parm. were made by Ryvarden (1973:9) and Parmasto (1968:103), respectively. Its close microscopical resemblance to *Caloporus taxicola* (Pers.:Fr.) Ryv. was additional reason for including it in those genera. *Ceriporia spissa* has better developed tubes and a polyporoid macromorphology (tubes up to 2.5-(5.0) mm long.) with 4.5-6 pores per mm; microscopically the hyphae, 2.1-5.2 µm wide, their parallel and compact arrangements in the dissepiments gives in transverse section a pseudoparenchymatous appearance



Figs 1-4: Microscopic cultural features of *Ceriporia mellea*: 1.generative hyphae of the mat; 2.incrusted generative hyphae; 3.sclerified generative hyphae; 4.emptied generative hyphae with yellowish guttulae.

which is absent in *Caloporus taxicola*. The extracellular matter in *C. taxicola* is chestnut reddish, giving the hymenophore a purplish colour upon drying. *C. taxicola* has a poorer tube development (only up to 1 mm long), and slightly larger pores (3-5 per mm); microscopically the hyphae are wider in average (3.1-7.2 µm) and are irregular and loosely arranged in the dissepiments, and the extracellular matter is smoky chestnut and gives the hymenophore a darker, almost vinaceous, tint upon drying. Lowe (1966:36) has also pointed out differences in substratun preferences, which we could not confirm. In spite of all these differences, spore shape and size are similar in both species. The principal anatomical character that separates *Ceriporia spissa* from *Caloporus taxicola* and which excludes the former from the genus *Caloporus* is the continuous hymenium over the folds found in the latter whereas sterile edges of dissepiments are found in *C. spissa*. Cultural characters of *Ceriporia spissa* support the exclusion of it from the merulioid genera and its inclusion in *Ceriporia* Donk.

CULTURE STUDIED: n°471: Argentina, Buenos Aires, Monte, Z. V. Dorna, leg. J. Deschamps BA-1724, 9.IV.72 =BAFC 27932.

GROWTH CHARACTERS: growth very slow, 2 cm/7 days, 3.8 cm/14 days, 5 cm/21 days, covering the plates at the end of the 6th week of study. Margin regular, hyaline and subfelty. Mats cream, becoming pink (Cupid Pink 1 E 8), subfelty in the advancing zone, felty towards the inoculum (Fig. 47). Odor stongly musty to somewhat fermented. Reverse unchanged. Oxidase reaction in GAA: - , 0 ; in TAA: - , 0 ; in TyA: - , 0 ; in pCA: - , 15 ; with GG: - .

MICROSCOPIC CHARACTERS: Advancing mycelium formed by simple septate, thin to slightly thick-walled generative hyphae, branched, 2.6-6.2 µm wide, with constrictions (Fig.5). Felty mat formed by similar generative hyphae, more branched, 1.6-7.8 µm wide, thin-walled or with walls thickened up to 1.0 µm (Fig. 6); amorphous yellowish crystal deposits (a resin?) are found on these hyphae, free in the agar (Fig.7) or inside sclerified generative hyphae (see below). Inoculum and submerged mycelium have similar generative hyphae plus simple septate, branched and sclerified generative hyphae, 5.2-7.8 µm wide, with walls up to 2.6 µm thick (Fig. 8). Fruitbodies did not develop in the plates but appeared erratically in tube slants as orange-yellowish spots. Their basidia are cylindric to clavate, tetraspored, 13.0-18.0 x 4.2-5.2 µm; basidiospores allantoid, 4.2-4.7 x 1.0-1.5 µm. Irregular yellowish crystals heavily incrust the hyphae and basidia, originating the macroscopic coloration.

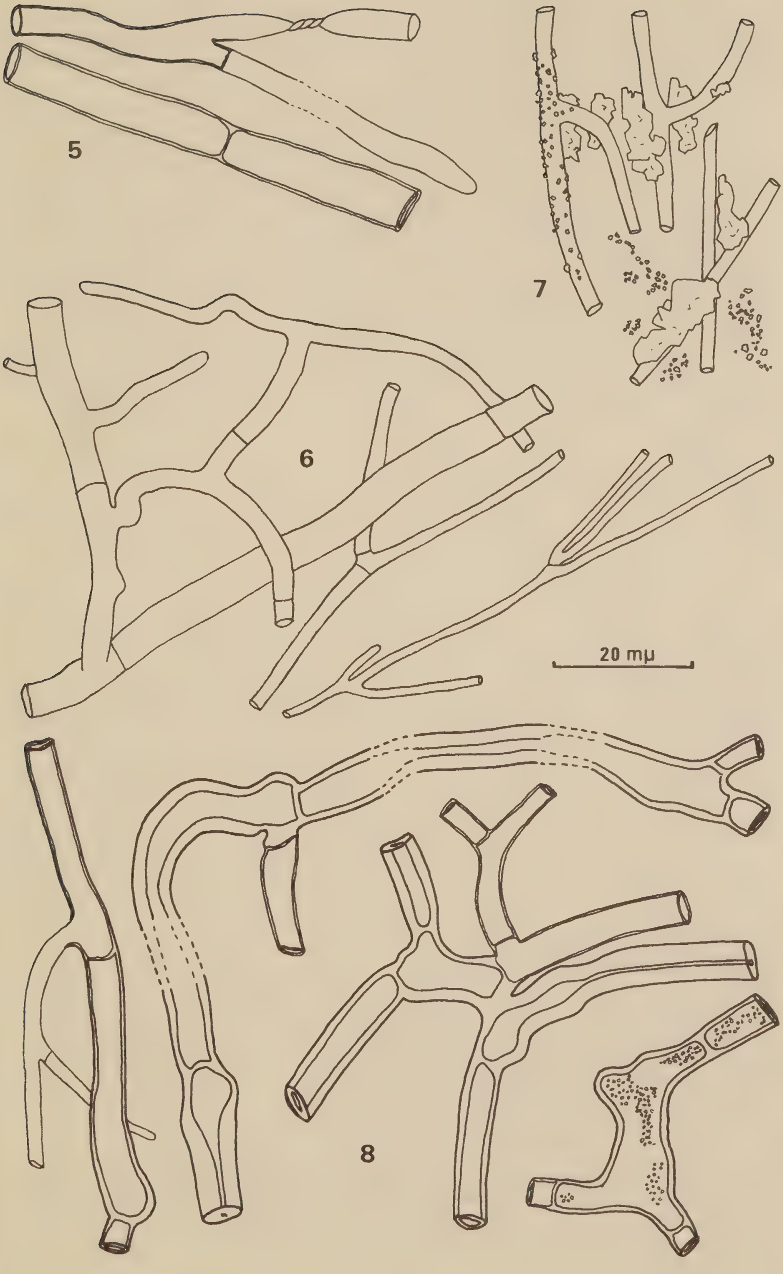
SPECIES CODE: 1. 6. 7. 32. 37. 38. 46. 53. 54.

REMARKS: Ginns (1976:102) established that multiclamped (verticillate) hyphae are typical in the advancing zones in cultures of *Caloporus* species (code n° 5, fide Nobles, 1965: 1103). This character was not found in our culture of *Ceriporia spissa*. The literature reveals that this feature points out differences between *Ceriporia* and *Caloporus* species, viz.:

TABLE I

Ceriporia purpurea (Nakasone & Gilbertson 1978:287)	1. 6.7.	*Caloporus ambiguus* (Nobles 1971:180; Ginns 1976:117)	1.5.7.
Ceriporia reticulata (Nobles 1971:180)	1.2.6.7.	*Caloporus corium* (Nobles 1971:180; Ginns 1976:126)	1.5.7.
Ceriporia spissa (Nobles 1971:180)	1.2.6.7.	*Caloporus hirtellus* (Ginns 1976:132)	1.5.7.
Ceriporia xylostromatoides (Nakasone & Gilbertson 1978:287)	2.6.7.	*Caloporus taxicola* (Nobles 1965:1120; Ginns 1976:151)	1.5.7.

Figs. 5-8: Microscopic cultural features of *Ceriporia spissa*: 5.generative hyphae of the advancing mycelium; 6.generative hyphae of the felty mat; 7.amorphous yellowish deposits on the hyphae; 8.sclerified generative hyphae, some with included yellowish deposits.


20 mμ

Ceriporia species only develop simple septate generative hyphae in culture, with or without coloured crystals or contents that colour the mats, and in some species sclerified generative hyphae are found[3].

Though all *Ceriporia* species are associated with a white rot they show a variable oxidase reaction in culture (as shown in Table I) that varies from negative, to weakly positive to distinctly positive. Kirk & Kelman (fide Ginns, 1976:153) "have attributed the lack of a reaction on the media to the lack of an inducer in the agar to trigger the production of oxidase. The possibility exists that this species and the others of *Meruliopsis* possess a different biochemical pathway, from that of the typical 'white rot' species, in causing a white rot". This might perhaps be the same case in other species of *Ceriporia*. If confirmed, an evolutionary relationship could be established between *Caloporus* Karst. and *Ceriporia* Donk, as indicated by Jülich and Stalpers (1980:16) and *C. spissa* could well be a bridge between both genera.

GRAMMOTHELE SUBARGENTEA (Speg.) comb. nov. (Figs. 9-16, 48)

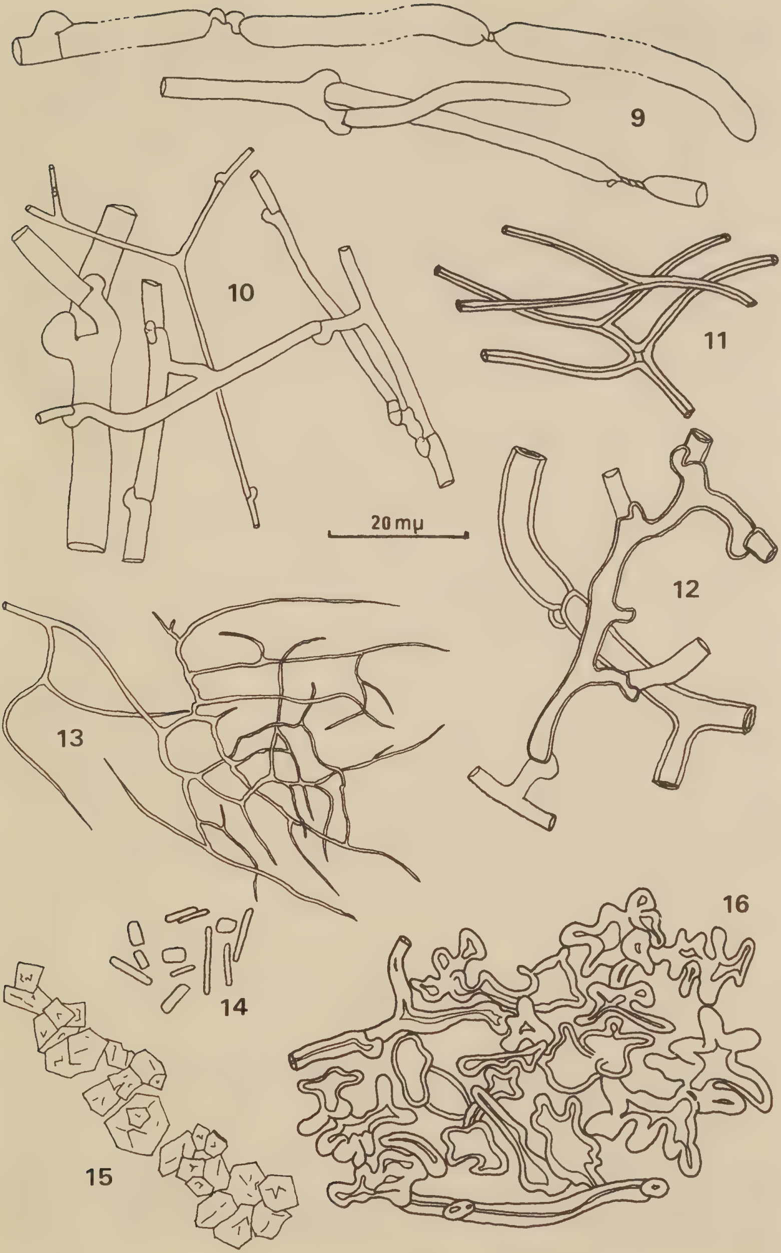
Basionym: *Poria subargentea* Speg., Rev. Arg. Hist. Nat. 1:104, 1891 (LPS ¡).
=*Poria pavonina* Bres., Hedwigia 35:282, 1896 (NY ¡).
=*Poria lilacino-rubra* Smith, in sched. (K ¡).

Lowe (1966:123) mistook this species and included it as a synonym of *Polyporus epimiltinus* Berk. & Br. (BPI ¡) (=*Tinctoporellus epimiltinus* (Berk. & Br.)Ryv.). Though it has the macroscopic aspect of a species of *Poria* Pers., and the hymenium does extend up to the vertical sides of the tubes in mature specimens, the microstructures are similar to those species of *Grammothele* Berk. & Curt., viz.: dimitic hyphal system with simple clamped generative hyphae and dextrinoid chestnut skeletal hyphae, cylindric hyaline spores (5.2-8.3 x 2.6-3.1 µm) and presence of dendrohyphidia in the borders of the dissepiments[4]. This species may redden the substratum with an oxide-like colour, present only as a narrow band in the limits of the rot, though it is not always evident. *G. lineata* Berk. & Curt. differs in having

[3] Unpublished data on cultural studies of *Ceriporia viridans* (Berk. & Br.)Donk have also revealed the same characters. Due to the morphological variations of this species (Lowe, 1966:32; Ryvarden et al., 1980:275) it was not deemed advisable to publish our results based on only one culture (BAFC n°806).

[4] Lowe (1966:275) already related the species to *Porogramme* Pat. when describing *Poria pavonina* Bres.

Figs. 9-16: Microscopic cultural features of *Grammothele subargentea*: 9.generative hyphae of the advancing zone; 10.wide and narrow generative hyphae of the aerial mat; 11.skeletal hyphae; 12.thick-walled generative hyphae; 13.hyaline hyphal mat; 14.arthrospores; 15.crystals; 16.plectenchyma.


20 mμ

a grammotheleoid macroscopic aspect, hyphal fascicles and smaller spores (4.2-5.7 x 2.1-2.6 µm).

CULTURES STUDIED: n°542: Argentina, Corrientes, Mburucuyá, Est. Santa María, leg. Wright, Deschamps & del Busto C-1915, 17.VIII.72 =BAFC 27921; n°2476, ibid., Saladas, Río Santa Lucía, leg. L. Rosensvaig C-1992, 10.XII.72 =BAFC 27920.

GROWTH CHARACTERS: growth rapid, 6.0-6.5 cm/7 days, plates covered in 2 wk. Margin regular. Mats at first loosely felty in the advancing zone and tightly so on the inoculum, becoming tightly woolly in the border of the colony and loosely so in the centre and on inoculum (Fig. 48). Mats always white, but dark reddish zones may develop underneath and colour the agar, covering a small portion or almost all the plates from the 3rd wk on. Odor sweet-fruity, later fungoid. Reverse unchanged, where reddish zones develop the agar becomes chestnut-red (Indian Red 6 L 12). Oxidase reaction in GAA: ++++ , 15 ; in TAA: ++++ , 0 ; in TyA: - , 10 ; in pCA: - (white precip.) , 0 ; with GG: + .

MICROSCOPIC CHARACTERS: Advancing zone with simple clamped, thin-walled generative hyphae, poorly branched, with constrictions, 2.6-7.3 µm wide (Fig. 9). Aerial mycelium formed with (a) simple clamped, thin-walled generative hyphae, branched, 2.1-6.2 µm wide (Fig. 10); (b) similar but narrower generative hyphae, 0.8-2.1 µm wide (Fig. 10); (c)skeletal hyphae scantily to regularly branched, 1.0-2.6 µm wide (Fig. 11); (d) simple clamped generative hyphae with up to 1.0 µm thickened walls (Fig. 12); (e) hyaline hyphal net, profusely branched, formed by empty slender hyphae, that confers on the mat its compact aspect (Fig. 13); (f) arthrospores prismatic, 2.6-11.4 x 1.0-2.1 µm, thin-walled (Fig. 14); and (g) polyhedric crystals on the agar (Fig. 15). Reddish zones are directly related with agelatinous pellicle submerged in the agar just under the surface and constituted of a plectenchyma formed by simple clamped generative hyphae with yellowish chestnut thickened walls with short protuberant branches, all strongly appressed and interwined, and embedded in a diffuse substance that dyes the agar (Fig. 16). A plectenchyma may also form under the uncoloured agar.

SPECIES CODE: 2a. 3. 8. 11. (21). 35. 36. 37. 39. 40. 42. 50. 54.

REMARKS: see page 289 for comparison with cultural studies of *Tinctoporellus epimiltinus* (Berk. & Br.)Ryv.

JUNGHUHNIA MICROSPORA Rajch. (Figs. 17-20, 49)
Mycotaxon 16:504, 1983.

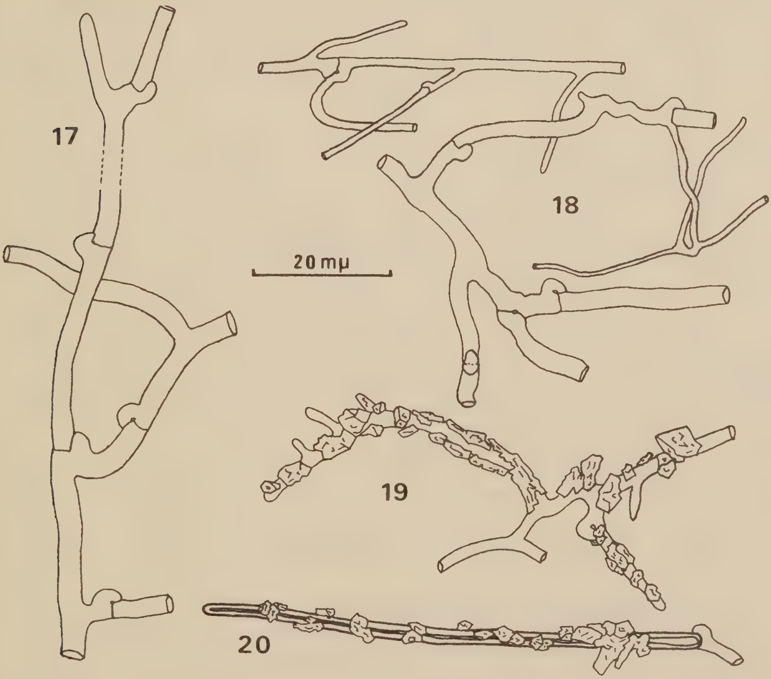
This species has been described recently from the Misiones subtropical forest (Rajchenberg, 1983:504).

CULTURE STUDIED: n°814: Argentina, Misiones, Nat'l Park Cataratas del Iguazú, road to Apepú, leg. M. Rajchenberg M-3504, 4.III.82 =BAFC 27993 (holotype).

GROWTH CHARACTERS: growth moderate, 3.1 cm/7days, 6.5 cm/14 days, covering the plate in 3 wk. Margin hyaline, subfelty and arachnoid radiating outwards in faint streaks. Mats hyaline, very thinly subfelty, with radially scattered small white spots of subfelty mycelium (Fig. 49). Odor none. Agar bleaching. Oxidase reaction in GAA: ++++ , 0 ; in TAA: ++++ , 0 ; in TyA: +++ , 15 ; in pCA: - (white precip.), 0 ; with GG: + .

MICROSCOPIC CHARACTERS: hyphae of the advancing zone simple clamped and thin walled, 3.6-5.2 μm wide (Fig. 17). Subfelty mats formed by simple clamped, thin-walled generative hyphae, branched, 1.0-3.1 μm wide (Fig. 18). From the 2nd wk onwards, first in the inoculum and later scattered in all the dish (distinctly corresponding to the white spots of mycelium) there appear generative hyphae with intercalarly or branched incrusted sections (Fig. 19) and short incrusted skeletal hyphae (Fig. 20).

SPECIES CODE: 2. 3. 8. 12. 32. 36. 40. 43. 54.



Figs.17-20: Microscopic cultural features of *Junghuhnia microspora*: 17.generative hyphae of the advancing zone; 18.generative hyphae of the mat; 19.incrusted generative hyphae; 20.incrusted skeletal hyphae.

REMARKS: growth and microscopic features coincide with those given by Lombard & Gilbertson (1966:827) for other species pertaining to *Junghuhnia* Corda which also are typified by subfelty mats, strong oxidase reactions, presence of incrusted generative hyphae and presence or absence of skeletal hyphae that may be incrusted or not.

MEGASPOROPORIA HEXAGONOIDES (Speg.)Wright & Rajch. in Ryv. & al., Mycotaxon 16:176, 1982.
(Figs. 21-24, 50)

This species has been recently transfered to the new genus *Megasporoporia* Ryv. & Wright and described in Ryvarden et al. (1982:176).

CULTURE STUDIED: n°2256: Argentina, Salta, Guemes, Río Mojotoro, leg. J. Deschamps SA-2910, 5.III.76 =BAFC 27917.

GROWTH CHARACTERS: growth moderate, 3 cm/7 days, 6 cm/14 days, covering the plate at the end of the 3rd wk. Margin regular, with subfelty mycelium. Mats white, with abundant mycelium, at first felty, later woolly, becoming densely appressed and with granular appearence (Fig. 50). Odor sweet, later fungoid. Reverse bleaching. Oxidase reaction in GAA: ++ , 0 ; in TAA: +++ , 0 ; in TyA: - , 0 ; in pCA: - (white precip.), 0 ; with GG: + .

MICROSCOPIC CHARACTERS: Advancing mycelium formed by simple clamped thin-walled generative hyphae, infrequently branched, 2.1-4.2 µm wide (Fig. 21). Felty mat formed by (a) simple clamped thin-walled generative hyphae, regularly branched, 1.6-4.7 µm wide (Fig. 22); (b) very narrow and much branched generative hyphae, 1.0-1.6 µm wide with very few to nearly absent clamps (Fig. 23); (c) skeletal hyphae with thick walls and poorly to regularly branched, 1.0-3.6 µm wide (Fig. 24); and (d) free crystals on the agar. Densely woolly mats formed by same elements but more abundant and tightly arranged; the last weeks the narrow generative hyphae empty and form a hyaline hyphal net that entangles and tightens all the hyphal elements (Fig. 29, as in *Megasporoporia setulosa* (Henn.)Rajch.).

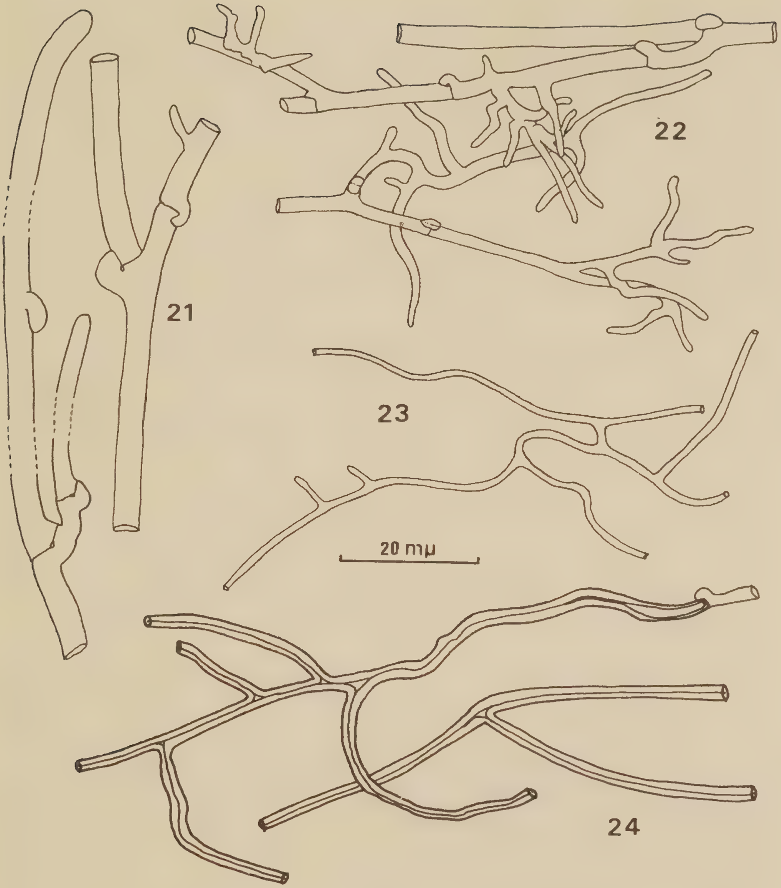
SPECIES CODE: 2a. 3. 8. 32. 36. 40. 43. 51. 54.

MEGASPOROPORIA SETULOSA (Henn.)Rajch. (Figs. 25-30, 51) in Ryv. & al., Mycotaxon 16:180, 1982.

This species has been described for the tropics by Ryvarden & Johansen (1980:45) and Ryvarden et al. (1982:180).

CULTURES STUDIED: n°198: Argentina, Misiones, Nat'l Park Cataratas del Iguazú, leg. M. Rajchenberg M-3508, 4.III.82 =BAFC 27965; n°793: ibid., leg. ipse M-3507 =BAFC 27966; n°2717: ibid., leg. Wright & Blumenfeld, M-3463, 7.III.81 =BAFC 27609.

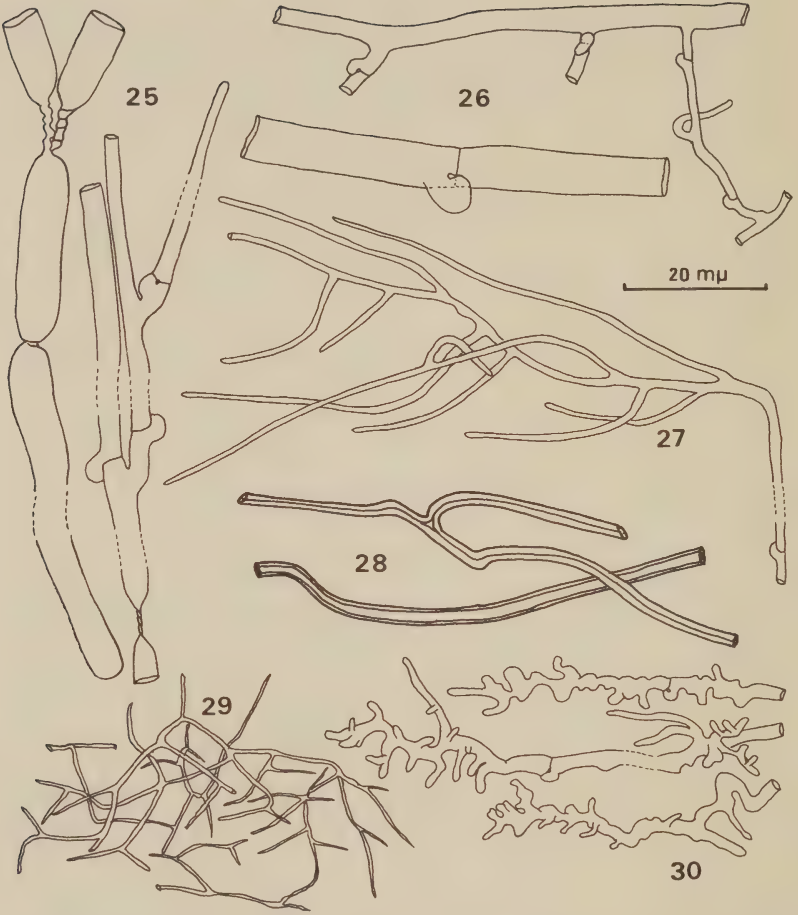
GROWTH CHARACTERS: growth moderately rapid, 4-5 cm/7 days, 8-8.5 cm/14 days, covering the plates during the 3rd wk. Advancing zone regular and hyaline. Mats white and quite



Figs. 21-24: Microscopic cultural features of *Megasporoporia hexagonoides*: 21.generative hyphae of the advancing zone; 22.regularly clamped generative hyphae of the felty mat; 23.much branched narrow generative hyphae; 24.skeletal hyphae.

abundant, at first felty, becoming subfelty toward the inoculum and chalk-like toward the margin or around all the plate (Fig. 51). Odor faintly sweet to absent. Reverse bleaching. Oxidase reaction in GAA: ++ to ++++ , 0 ; in TAA: ++ to +++ , 0 ; in TyA: + , 10 ; in pCA: - (white precip.), 0 ; with GG: + .

MICROSCOPIC CHARACTERS: Advancing mycelium formed by simple clamped, thin-walled generative hyphae, 2.6-6.1 μm wide, with constrictions (Fig.25). Felty and subfelty mats formed by (a) simple clamped, thin-walled generative hyphae,poorly



Figs. 25-30: Microscopic cultural features of *Megasporoporia setulosa*: 25.generative hyphae of the advancing zone; 26.wide generative hyphae of the felty mat; 27.narrow generative hyphae; 28.skeletal hyphae; 29.hyaline, much branched generative hyphae that form the hyphal net; 30.submerged generative hyphae.

to profusely branched, wide (Fig. 26) or narrow (and then with few clamps) (Fig. 27), 0.5-6.8 µm wide; (b) skeletal hyphae, poorly to profusely branched, 1.0-3.1 µm wide, with thickened walls (Fig. 28). Chalk-like mats formed by same elements plus an abundant and profusely branched hyaline net that originates from the narrow generative hyphae (Fig. 29) that strongly tightens other hyphal elements and is responsible of the mat texture. Submerged mycelium formed by distinct branched generative hyphae with protuberances (Fig.30).

SPECIES CODE: 2. 3. 8. 32. 36. 40.43. 50. 54.

REMARKS: Mat texture and presence of distinct submerged generative hyphae are the only characters that permit the separation by culture of this species from *M. hexagonoides*. Both species possess cultural features, reflected in their species code, which justify their taxonomic association.

SKELETOCUTIS NIVEA (Jungh.)Kell. var. *DILUTA* Rajch.
Mycotaxon 16:505, 1983. (Figs. 31-38, 52)

This variety has been described recently from implanted woods in the subtropical province of Misiones (Rajchenberg, (1983:505).

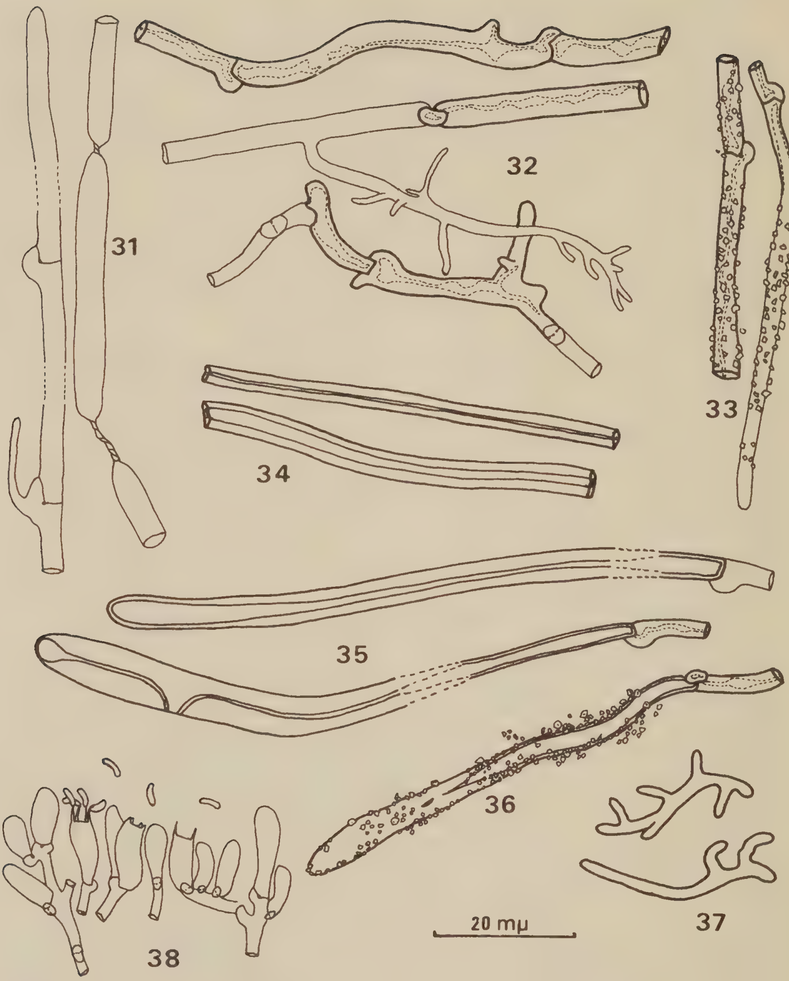
CULTURE STUDIED: n°2348: Argentina, Misiones, Iguazú, Puerto Libertad, leg. S. Blumenfeld, 25.III.81, on fallen branches of *Pinus taeda* =BAFC 27657.

GROWTH CHARACTERS: growth rapid, 4.5 cm/7 days, covering the plates in 2 wk. Margin regular, hyaline and subfelty. Mats hyaline and subfelty during all the study, but woolly white spots develop first on the inoculum and later irregularly scattered throughout the dish and form fruitbodies after the 2nd wk (Fig. 52). Odor none to faintly sweet. Reverse unchanged. Oxidase reaction in GAA: ++++ , 0 ; in TAA: +++ , 0 ; in TyA: ++ , 0 ; in pCA: - , 0 ; with GG: + .

MICROSCOPIC CHARACTERS: Hyphae of the advancing zone simple clamped, thin-walled, 2.1-4.7 µm wide, poorly branched and with constrictions (Fig. 31). Subfelty mat formed by simple clamped generative hyphae, narrow to wide, branched, with thin to irregularly thickened walls, 1.0-5.7 µm (Fig. 32), sclerifying during the study. Woolly spots and fruitbodies formed by (a) similar generative hyphae; (b) generative hyphae with intercalarly or terminal incrustations (Fig. 33); (c) unbranched skeletal hyphae, 2.1-4.7 µm wide, with thickened walls that dissolve in 5% KOH and are slightly amyloid (Fig. 34); (d) wide, unbranched skeletal hyphae, 4.2-7.3 µm wide, with thickened inamyloid walls not dissolving in KOH solution and with a narrow lumen that widens at the apex (Fig. 35); (e) incrusted cystidia formed by sclerified terminal cells (Fig. 36); and (f) few binding hyphae that appeared in the last wk, 1.0-2.6 µm wide, with totally thickened walls (Fig. 37). Hymenium with cylindric to clavate, tetraspored basidia, 7.8-12.0 x 2.1-3.6 µm; basidiospores allantoid, hyaline, thin-walled, 3.1-3.6 x 0.5 um, inamyloid and acyanophilous (Fig. 38).

SPECIES CODE: 2. 3. 8. 9. 12. 14. 32. 36. 38. 43. 48. 50. 53. 55.

REMARKS: our study reveals important cultural differences from those given by Nobles (1965:1129) for the typical variety. The latter differs in its slower growth (mycelium does not cover the dish in 6 wk), its lack of fruitbody formation and of cystidia and skeletal hyphae (which are men-



Figs. 31-38: Microscopic cultural features of *Skeletocutis nivea* var. *diluta*: 31.generative hyphae of the advancing zone; 32.generative hyphae with irregularly thickened walls; 33.incrusted generative hyphae; 34.skeletal hyphae with dissolving walls; 35.skeletal hyphae with undissolved walls; 36.cystidia; 37.binding hyphae; 38.basidia and basidiospores.

tioned by Stalpers, 1978:94). The similarity with basidiocarp features given previously (Rajchenberg, op. cit.) is remarkable.

TINCTOPORELLUS EPIMILTINUS (Berk. & Br.)Ryv.
(Figs. 39-45, 53)
Trans. Brit. Myc. Soc. 73:18, 1979.

This species has been described by Lowe (1966:123), Ryvarden (1979:18) and Ryvarden & Johansen (1980:554).

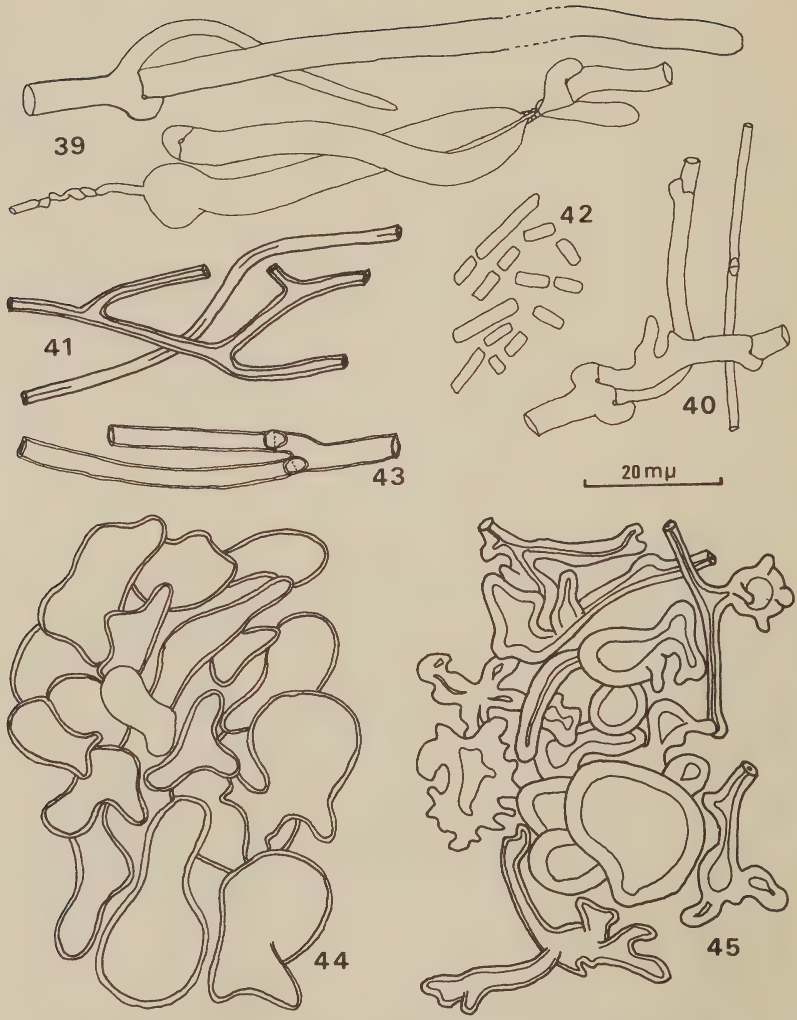
CULTURE STUDIED: n°415: Argentina, Misiones, Nat'l Park Cataratas del Iguazú, leg. M. Rajchenberg M-3487, 1.III.82 =BAFC 27963.

GROWTH CHARACTERS: growth very rapid, 7.5 cm/7 days, covering the plate in 2 wk. Margin regular. Mat white, irregularly felty or loosely woolly with subfelty zones in the margins and turning tightly felty in the margin in the last weeks (Fig. 53). As from the 2nd wk red zones develop in the margins or the center of the plates under the mats, at first light orange (11 F 9) becoming dark purplish to almost vinaceous, and colouring the mycelium. Odor faintly sweet or fungic. Reverse unchanged, with chestnut reddish zones (Chrysantemum 5 L 12, Indian Red 6 A 12) corresponding with those of anverse. Oxidase reaction in GAA: ++++ , 10 ; in TAA: ++ , 0 ; in TyA: - , 90 ; in pCA: - , 0 ; with GG: + .

MICROSCOPIC CHARACTERS: Advancing mycelium formed by simple clamped thin-walled generative hyphae, infrequently branched, with constrictions, 3.6-7.8 µm wide (Fig. 39). Aerial mycelium formed by (a) simple clamped thin-walled generative hyphae, poorly to regularly branched, narrow to wide, 2.1-8.3 µm (Fig. 40); (b) skeletal hyphae, thick-walled and branched, 0,8-2,6 µm wide (Fig. 41); (c) arthrospores cubic to prismatic, 3.1-13.0 x 1.6-2.1 µm (Fig. 42); (d) simple clamped, slightly thick-walled generative hyphae without cytoplasmic contents, 4.2-6.2 µm wide (Fig. 43); and (e) free crystals in agar. Submerged mycelium forming a pseudoparenchyma just under the agar surface and the felty mats, formed from the 3rd wk on by very deformed cells, irregularly widened and swollen and with thickened walls (Fig. 44). Reddish zones formed by a plectenchyma formed by generative hyphae with chestnut thickened walls, skeletal hyphae and much modified branched swollen hyphae with thickened walls, all of them tightly interwined and embedded in an amorphous extracellular substance that reddens the medium (Fig. 45).

SPECIES CODE: 2a. 3. 8. 10. 11. (21). 35. 36. 37. 39. 40. 42. 50. 54.

REMARKS: growth and microscopic features plus similar species codes point out a notable relationship between *Tinctoporellus epimiltinus* (Berk. & Br.)Ryv. and *Grammothele subargentea* (Speg.)Rajch. (see p.282), which differs principally in lacking a pseudoparenchyma in culture. Ryvarden (1979:18) related *Tinctoporellus* Ryv. to *Antrodia* Karst. (=*Coriolellus* Murr.) which differs radically in having generative hyphae with irregularly thickened walls (at least in culture), hyaline skeletal hyphae and producing a different rot (brown) in substrata. With *Grammothele subargentea* this species shares a similar hyphal system (with simple clamped thin to slightly thick-walled generative hyphae and yellowish

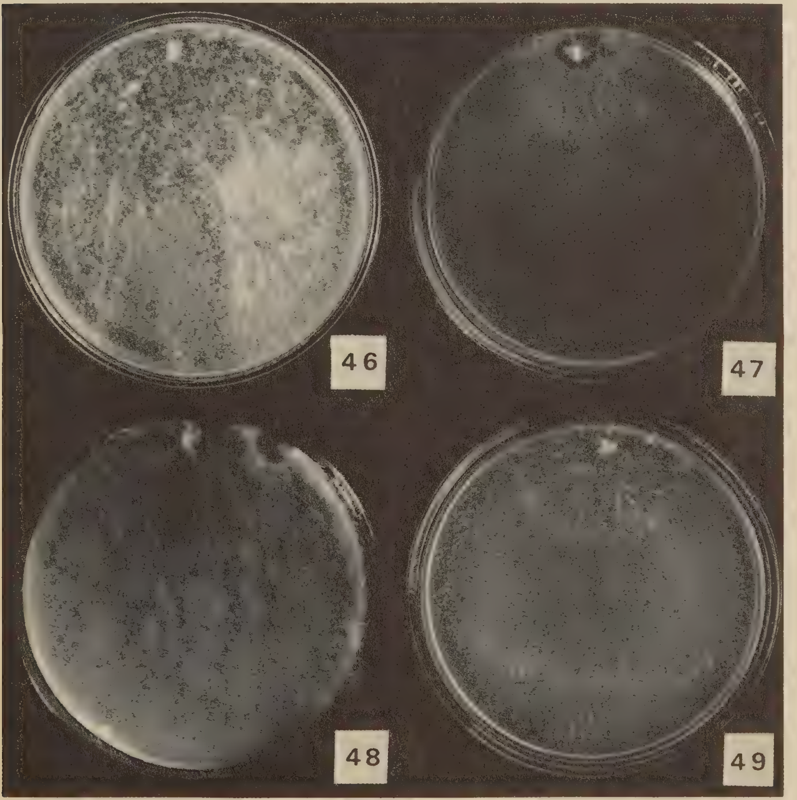


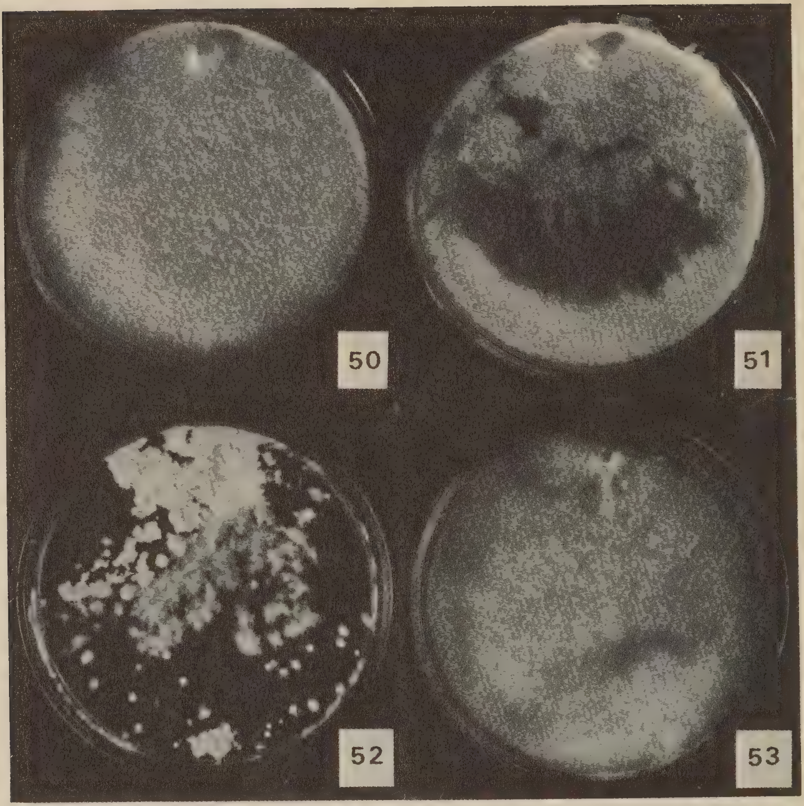
Figs. 39-45: Microscopic cultural features of *Tinctoporellus epimiltinus*: 39.generative hyphae of the advancing zone; 40.generative hyphae of the aerial mycelium; 41.skeletal hyphae; 42.arthrospores; 43.slightly thick-walled generative hyphae; 44.pseudoparenchyma; 46.plectenchyma.

Figs. 46-49: Macroscopic aspects (x 0.6) of mats in culture (4 wk old) of: 46.*Ceriporia mellea*; 47.*Ceriporia spissa*; 48.*Grammothele subargentea*; 49.*Junghuhnia microspora* to chestnut skeletal hyphae with dextrinoid reaction), producing a white rot in substrata, and dyeing the substratum with red-oxide tints (though in *T. epimiltinus* the coloration is always evident and widespread and in *G. subargentea* it is hardly seen only in the limits of the rot). Both genera differ in the following characters:

Tinctoporellus	*Grammothele*
Spores subglobose to broadely ellipsoid	Spores cylindric
Hymenophore distinctly tubular, 1-several layered	Hymenophore grammotheleoid to tubular
Dendrohyphidia absent	Dendrohyphidia present

Cultural features were surprisingly similar between *Tinctoporellus epimiltinus* and *Grammothele subargentea*, principally in the capacity to redden the agar, form a plectenchyma, produce quite abundant mycelium, and similar growth and oxidase reactions. In conjunction with the morphological features a relationship can be established between both taxa. Sexual and cytological studies are highly needed to confirm this hypothesis.





Figs. 50-53: Macroscopic aspects (x 0.6) of mats in culture (4 wk old) of: 50.*Megasporoporia hexagonoides*; 51.*Megasporoporia setulosa*; 52.*Skeletocutis nivea* var. *diluta*; 53.*Tinctoporellus epimiltinus*

ACKNOWLEDGEMENTS

I want to express my warm gratitude to Dr. J. E. Wright (University of Buenos Aires) for his constant aid and guidance during this work.

Special thanks are due to Mr. Emilio del Busto for his technical assistance and for maintaining cultures at BAFC, and to Edy Warman for preparing the photographic plates.

I am grateful to Dr. M. Larsen (USDA, Madison) and to Dr. J. Ginns (Ottawa) for critically reviewing the manuscript and making unvaluable suggestions.

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TETRAPOLAR HETEROTHALLISM IN JUNGHUHNIA COLLABENS (BASIDIOMYCETES: APHYLLOPHORALES)

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The type of the incompatibility mechanism was determined in a specimen of *Junghuhnia collabens* (Fr.) Ryv. collected in the Järvselja Forest Nature Reserve, Estonian SSR, on a fallen trunk of *Picea abies*, June 25, 1981, by E. Parmasto (TAA no. 100269). The single spore isolates were obtained from the spore deposit shed during a night in laboratory conditions, using the nonquantitative dilution method in sterile destilled water (Macrae, 1967). From every dilution some drops of spore suspension were transferred on malt agar in Petri dishes of 10 cm in diameter. The Petri dishes were incubated at room temperature (about 22-24°C) in the dark and examined every day. Germination occurred in 3-4 days. The spots of young mycelium were transferred to the tubes of slanted 2.0% malt agar and allowed to grow about two to three weeks. Each isolate was examined microscopically; isolates without clamp connections were assumed to be monokaryotic.

The incompatibility test was made using 12 single spore isolates. Edwards and Kennedy (1973) have been stated that a minimum of 12 monosporous cultures should be paired to reasonably ensure that all four mating-types will be dedected. The monosporous isolates were paired in all possible combinations among themselves on 2.0% malt extract agar in 70 mm Petri dishes according to the procedures of Macrae (1967). The paired isolates were incubated at room temperature (at about 22-24°C) in the dark for about two to three weeks. The mycelium from the line of contact between paired isolates was examined microscopically in KOH + phloxine and KOH + erythromycine for the presence or absence of clamp connections.

The results of crosses of monosporous isolates from a single basidiocarp show that *Junghuhnia collabens* is heterothallic and has a tetrapolar mating incompatibility system. The distribution of mating types among the monosporous isolates is summarized as follows:

A_1B_1 - 1, 10, 14
A_1B_2 - 6, 7, 8, 9, 12
A_2B_2 - 2, 4, 11
A_2B_1 - 13

Several authors have described the great similarity of the basidiocarps in the genera *Junghuhnia* Ryv. (Syn.: *Chaetoporus* P. Karst.), *Steccherinum* S.F. Gray, and *Irpex* Fr., considered by many other authors to belong to different families (Polyporaceae and Hydnaceae s.l.). Maas Geesteranus (1974) gave a comprehensive review of this similarity. Parmasto (1968) described a new family Steccherinaceae Parm. and included all three genera mentioned in the subfamily Steccherinoideae.

The type of sexuality has been determined in three species of the genera *Steccherinum* and *Junghuhnia*. *Steccherinum ochraceum* (Pers. : Fr.) S.F. Gray (Kimura, 1954; Takemaru & Fuijoka, 1970); *S. oreophilum* Lindsey & Gilbn. (Ginns, 1982), and *Junghuhnia nitida* (Pers. : Fr.) Ryv. (Syn.: *Poria eupora* (P. Karst.) Cooke) (Nobles, Macrae & Tomlin, 1957), as well as *J. collabens*, studied by us, are heterothallic and tetrapolar. *Irpex lacteus* (Fr. : Fr.) Fr., a species lacking clamp connections, is presumably homothallic (David, 1969: 200). The report (Boidin & Lanquetin, 1965) that *I. lacteus* was tetrapolar was based upon the study of a misidentified specimen (Maas Geesteranus, 1974: 448). Gilbertson (1971: 284) has mentioned that "some genera that form reasonable natural groupings seem to be rather uniform as far as the type of sexuality is concerned". The data on the type of sexuality presented here are in accord with the asserted close relationship of *Steccherinum* and *Junghuhnia* mentioned above.

ACKNOWLEDGEMENTS

The author wishes to thank Dr. J. Ginns for reviewing this paper and Dr. E. Parmasto for his criticism.

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VALIDATION OF THE NAMES OF SOME *CANDIDA* SPECIES

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During a revision of the genus *Candida* for the third edition of "The Yeasts - A Taxonomic Study", [N.J.W. Kreger-van Rij, ed., North-Holland Publ. Co., Amsterdam, (in press)] some names were encountered which are in use without having been published in accordance with the International Code of Botanical Nomenclature. The purpose of this article is to publish these names in the form required by Art. 33 and to validate some new combinations which are introduced in the above-mentioned publication.

Candida buffonii (Ramirez) van Uden & Buckley nov. comb. Basionym: *Torulopsis buffonii* Ramirez 1957 - Microbiol. Espan. 10, 238. Type strain: CBS 2838.

Candida conglobata (Redaelli) van Uden & Buckley nov. comb. Basionym: *Torulopsis conglobata* Redaelli 1925 - I miceti come associazone microbia nella tuberculosi polmonare cavitaria. Osservazioni micropatologiche, istopatologice e sperimentale. Mem. Prem. R. lst. Lombardo Sci. Lett. p. 60. Type strain: CBS 2018, van Uden & Buckley *in* Lodder 1970 - The Yeast - A Taxonomic Study. N.-Holland Publ. Co., Amsterdam & London, p. 945.

Candida diddensiae (Phaff, Mrak & Williams) Fell & Meyer nov. comb. Basionym: *Trichosporon diddensii* Phaff et al. 1952 - Mycologia 44, 440: Type strain: CBS 2214.

Candida fennica (Sonck & Yarrow) Meyer & Ahearn nov. comb. Basionym: *Trichosporon fennicum* Sonck & Yarrow 1969 - Antonie van Leeuwenhoek 35, 174. Type strain: CBS 5928. Justification: failure to form arthroconidia, cell wall of the ascomycetous two-layered type, Diazonium Blue B test negative, urease test negative.

Candida kefyr (Beijerinck) van Uden & Buckley nov. comb. Basionym: *Saccharomyces kefyr* Beijerinck 1889 - Arch. Neerland. Sci. Exactes et Naturelles 23, 212. Type strain: CBS 834, van Uden & Buckley *in* Lodder 1970 - The Yeasts - A Taxonomic Study. N.-Holland Publ. Co., Amsterdam & London, p. 982.

Candida lambica (Lindner & Genoud) van Uden & Buckley nov. comb. Basionym: *Mycoderma lambica* Lindner & Genour 1913 - Woch. Brau. 30, 366. Type strain: CBS 1876.

Candida lodderae (Phaff, Mrak & Williams) Meyer & Ahearn nov. comb. Basionym: *Trichosporon lodderi* Phaff et al. 1952 - Mycologia 44, 441. Type strain: CBS 1924. Justification: failure to form arthroconidia, Diazonium Blue B test negative, urease negative.

Candida maritima (Siepmann) van Uden & Buckley nov. comb. Basionym: *Trichosporon maritimum* Siepmann *in* Siepmann Höhnk 1962 - Veröffentlich. Inst. Meeresforsch. Bremerhaven 8, 89. Type strain: CBS 5107, van Uden & Buckley *in* Lodder 1970 - The Yeasts - A Taxonomic Study. N.-Holland Publ. Co., Amsterdam & London, p. 1003.

Candida melibiosophila Golubev nom. nov. Replaced synonym: *Torulopsis melibiosum* Shifrine & Phaff 1956 - Mycologia 48, 49. Type strain: CBS 2102.

Candida peltata (Yarrow) Meyer & Ahearn nov. comb. Basionym: *Torulopsis peltata* Yarrow 1968 - Antonie van Leeuwenhoek 34, 81. Type strain: CBS 5576. Justification: Following the finding that the teleomorph of the other species (*S. intestinalis*) which was classified in the same genus is a species of *Metschnikowia* the formation of lunate cells is considered an insufficient reason to maintain *Selenozyma*.

Candida pintolopesii (van Uden) Meyer & Yarrow var. *slooffiae* Mendonca-Hagler & Phaff nov. var. Synonym: *Candida slooffii* van Uden & do Carmo Sousa. Latin diagnosis in van Uden & do Carmo Sousa 1956 - Port. Acta Biol., Ser. A 4, 13.

Candida sake (Saito & Ota) van Uden & Buckley nov. comb. Basionym: *Eutorulopsis sake* Saito & Ota 1934 - J. Brewery Sci. 12, 166. Type strain: CBS 159.

Candida salmanticensis (Santa Maria) van Uden & Buckley nov. comb. Basionym: *Torulopsis salmanticensis* Santa Maria 1963 - Antonie van Leeuwenhoek 29, 341. Type strain: CBS 5121.

Candida valida (Leberle) van Uden & Buckley nov. comb. Basionym: *Mycoderma valida* Leberle 1909 - Beitrage zur Kenntnis der Gattung Mycoderma. Thesis, Munich, p. 73. Type strain: CBS 683, van Uden & Buckley *in* Lodder 1970 - The Yeasts - A Taxonomic Study. N.-Holland Publ. Co., Amsterdam & London, p. 1068.

Candida vartiovaarai (Capriotti) van Uden & Buckley nov. comb. Basionym: *Torulopsis vartiovaarai* Capriotti 1961 - Can. J. Microbiol. 7, 683. Type strain: CBS 4289, van Uden & Buckley *in* Lodder 1970 - The Yeasts - A Taxonomic Study: N.-Holland Publ. Co., Amsterdam & London, p. 1070.

Candida vini (Vallot *ex* Desmazieres) van Uden & Buckley nov. comb. Basionym: *Mycoderma vini* Vallot *ex* Desmazieres 1827 (non *Mycoderma vini* Grawitz 1877 nec *M. vini* de Rossi 1917) Ann. Sci. Naturelles 10, 65. Type strain: CBS 639, van Uden & Buckley *in* Lodder 1970 - The Yeasts - A Taxonomic Study. N.-Holland Publ. Co., Amsterdam & London, p. 1076.

MYCOTAXON

Vol. XVII, pp. 299-300 April-June 1983

SOME CORTICOLOUS MYXOMYCETES FROM BOMBAY

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Samples of bark from an unidentified, isolated tree growing on Sheva Island at the eastern side of Bombay harbour, were collected in September 1978 by R.McIntosh and sent to the writer. The bark was placed in moist chamber in late September and sporangia began to appear in mid-October. It is interesting to note that the myxomycetes were slower to develop than usual, even the *Licea* species, and this may have been due to the marked difference in ambient temperature between the collection site, at more than 40C, and the British laboratory, at 20C. Five myxomycetes had been detected by the time the cultures were abandoned in mid-February 1979. All material is preserved in the writer's herbarium.

Arcyria cinerea (Bull.)Pers. Numerous small colonies of this common bark species were found. The bark form is usually long-stalked and rarely shows the tendency to cluster-often seen in tropical lignicolous gatherings.

Echinostelium elachiston Alexop. Large developments in October. This species was recorded from Delhi by Lakhanpal & Mukerji (1981); it is reported from Europe and North America but is probably often confused with the commoner *E. colliculosum* Whitney & Keller.

E. minutum de Bary Small groups and scattered sporangia appeared in late October, looking larger and paler than *E. elachiston*. This species is common in Europe and the Americas and is probably cosmopolitan.

Licea belmontiana Nann.-Brem. Numerous minute black sporangia developed in November on six of the twelve bark samples. This species was hitherto known only from the Netherlands and Great Britain; this second Indian record follows its report from Himachel Pradesh (Dhillon, 1978).

L. kleistobolus Martin Small groups of shining brown sporangia developed in late October on the smoothest raised areas of bark. This species is widely distributed in Europe and North America but is new to Asia.

Thanks are due to Mr R. McIntosh for collecting the bark and to Mrs J. McIntosh for transporting it to Great Britain.

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Dhillon, S.S. 1978. Myxomycetes new to India 1. Sydowia 30, 1-5. Lakhanpal, T.N. & Mukerji, K.G. 1981. Taxonomy of the Indian Myxomycetes. Vaduz, J. Cramer.

MYCOTAXON

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NOTES ON HYPHOMYCETES. XLIV.
NEW AND RARE DEMATIACEOUS SPECIES FROM THE TRANSVAAL

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ABSTRACT

Seven dematiaceous hyphomycetes are described and illustrated from collections made in the Transvaal, South Africa. Five of these, namely *Chloridium transvaalense*, *Dendryphiopsis biseptata*, *Guedea ovata*, *Paradendryphiopsis anomala* and *Parasympodiella africana* are new species. *Chloridium matsushimae* and *Melanocephala triseptata* are recorded from this locality for the first time.

INTRODUCTION

Continued collecting of lignicolous and foliicolous dematiaceous hyphomycetes in the vicinity of Mariepskop and in the Debengeni Forest Reserve, northeastern Transvaal, Republic of South Africa, has led to the discovery of a significant number of taxa not previously known and of many species which, judging from the paucity of records, are considered to be rare and noteworthy. In the present paper five new species are described and *Chloridium matsushimae* W. Gams and Holubová-Jechová and *Melanocephala triseptata* (Shearer, Crane and Miller) Hughes are recorded.

TAXONOMIC PART

Chloridium matsushimae W. Gams and Holubová-Jechová, Studies in Mycology 13: 28, 1976 (Fig. 1).

Colonies broadly effuse, sparse, dark brown, hairy. Mycelium mostly immersed in the substratum, composed of branched, cylindrical, smooth, septate, very pale yellowish brown to brown, 2 - 3µm wide

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hyphae; hyphal cells occasionally swollen to 4µm in diameter proximal to the point of origin of the conidiophores. Conidiophores macronematous, mononematous, mostly solitary, rarely in a loose fascicle of two or three, erect, simple, straight, septate, smooth, occasionally proliferating percurrently once or twice, or rarely three times, mid brown, paler towards the apex, especially following proliferation, slightly bulbous at the base, up to 160µm long, 4 - 5µm wide, swollen to 10µm wide at the base. Conidiogenous cells monophialidic, integrated, terminal, cylindrical, bearing a distinct, flaring, funnel-shaped collarette. Conidia cylindrical to narrowly ellipsoidal, sometimes slightly constricted laterally towards the middle, hyaline, smooth, broadly obtuse at the apex, frequently somewhat papillate at the extreme base, continuous, 14 - 15 X 3.5 - 4.5µ, bearing a single, narrow, filiform, mucilaginous appendage at the extreme apex.

On dead stems and wood; Japan and South Africa.

Collections examined: on unidentified, decorticated wood, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA.

Chloridium matsushimae was originally described from rotting stems of *Phyllostachydis edulis* collected in 1966 in Kyoto, Japan and designated *Chloridium* sp. MFC-1640 by Matsushima (1975), who was unsure of its taxonomic status. Gams and Holubová-Jechová (1976), in their monographic study of *Chloridium* Link, without examining the holotype but quoting Matsushima's description verbatim [in translation], subsequently established the name. The South African collection represents the second record of its occurrence. It is identical to the Japanese material in all essential details except that the conidia are on the short side (those of MFC-1640 are 15-19µm in length). In the South African material many conidia lack the mucilaginous apical appendage or at least these are not discernible even in water mounts viewed with phase contrast illumination.

Chloridium transvaalense sp. nov. (Fig. 2).

Coloniae effusae, brunneae vel griseo-brunneae, pilosae. Mycelium plerumque in substrato immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, laevibus, 2 - 2.5µm crassis compositum. Conidiophora macronemata, mononemata, solitaria vel interdum fasciculata, erecta, simplicia, recta vel leniter flexuosa, septata, brunnea vel pallide brunnea, apicem versus pallidiora, laevia, ex basibus bulbosis, 33 - 138 X 3 - 4µm, basi interdum ad 8µm inflata. Cellae conidiogenae monophialidicae, in conidiophoris integratae, terminales, cylindricae vel anguste clavatae, cum collis infundibuliformiae. Conidia singulatim successive in collo formata, continua, oblonga, hyalina, laevia, 4 - 5 X 1.5µm.

In foliis emortuis, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotypus.

Colonies effuse, brown to greyish brown, hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth, 2 - 2.5µm wide hyphae. Conidiophores macro-

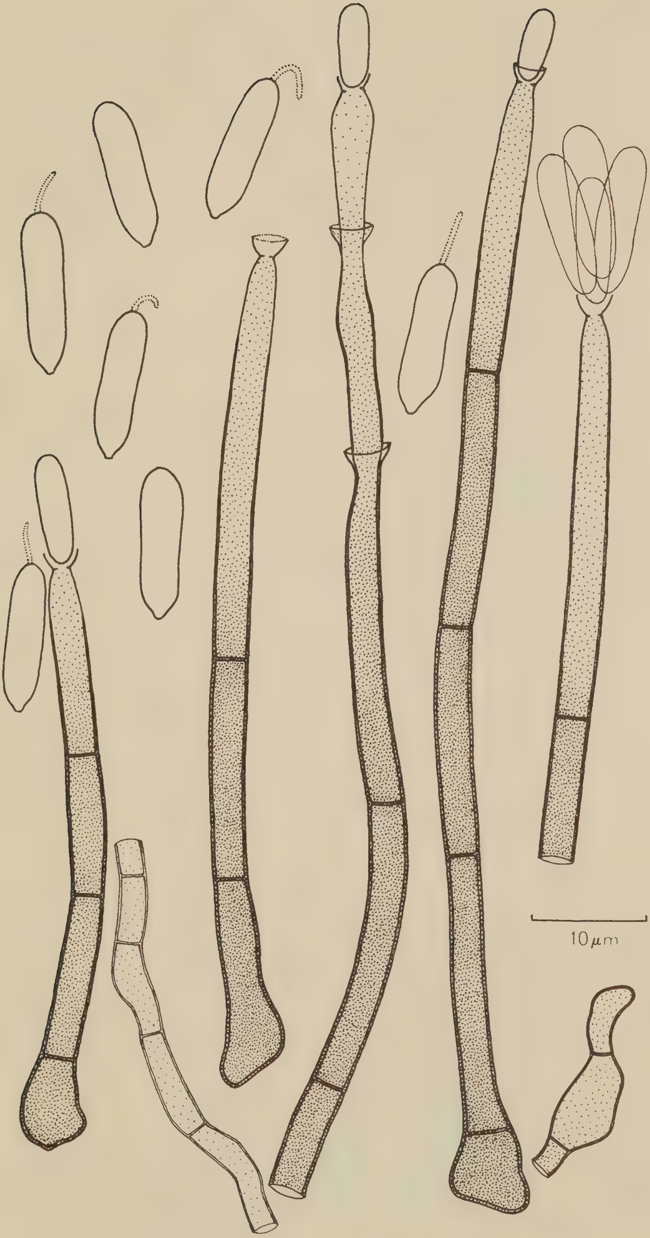

FIGURE 1. *Chloridium matsushimae*

nematous, mononematous, solitary or sometimes in loose fascicles of a few, erect, simple, straight or slightly flexuous, septate, brown to pale brown, paler towards the apex, smooth, usually with a somewhat bulbous base, 33 - 138 X 3 - 4µm, swollen to 8µm wide at the base; when in fascicles a single long conidiophore is usually accompanied by one or two considerably shorter, paler ones. Conidiogenous cells monophialidic, integrated, terminal, cylindrical to narrowly clavate, up to 5µm wide in their broader middle section, bearing a single, flaring, flask-shaped, 2.5 - 3µm wide collarette. Conidia produced singly, successively, within the collarette, aggregating in slimy masses, continuous, oblong, hyaline, smooth, 4 - 5 X 1.5µm.

On dead leaves; South Africa.

Collection examined: on unidentified dead leaf from forest leaf litter, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotype.

Chloridium transvaalense belongs in section *Gongromeriza* (Preuss) W. Gams and Holubová-Jechová of *Chloridium* Link which is characterized by conidiophores where serial production of conidia occurs from a single conidiogenous locus located within the collarette. Unlike most other species classified in this section no percurrent proliferation of the conidiophores to form successive conidiogenous loci occurs however. In this regard *C. transvaalense* resembles *C. reniforme* Matsushima which has also similarly shaped conidiogenous cells as does, incidentally, *Codinaea cylindrospora* Morgan-Jones and Ingram.

Codinaea cylindrospora, which Morgan-Jones and Ingram (1976) noted to be not entirely typical of *Codinaea* Maire, bears enough resemblance to *C. transvaalense* to be considered congeneric with it. In view of the fact that a number of cylindrical spored species have been added to *Chloridium* by Gams and Holubová-Jechová (1976) and its similarity to *C. transvaalense*, *C. cylindrospora* might well be more appropriately classified in that genus. A transfer to *Chloridium* would, however, create a later homonym of *Chloridium cylindrosporum* W. Gams and Holubová-Jechová necessitating the establishment of a new specific epithet for it. This will be considered further eleswhere.

Chloridium transvaalense comes closest to *Chloridium lignicola* (Mangenot) W. Gams and Holubová-Jechová from which it differs in the shape of its conidiogenous cells, lack of conidiophore proliferation and in the shape of its conidia, those of *C. lignicola* being narrowly ellipsoid rather than distinctly oblong. *C. lignicola*, which is known from five collections, made in Canada, Belgium, France and in New York, U.S.A. (Gams and Holubová-Jechová, 1976), has also been collected in South Africa [on dead decorticated wood, Golden Gate Highlands National Park, Orange Free State, March 14, 1979, R.C. Sinclair, AUA].

Dendryphiopsis biseptata sp. nov. (Fig. 3).

Coloniae effusae, fuscae vel atrae, pilosae. Mycelium in substrato immersum, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2 - 3µm crassis compositum. Conidiophora macronemata, mononemata, ex apice lateribusque hypharum oriunda, erecta, recta vel

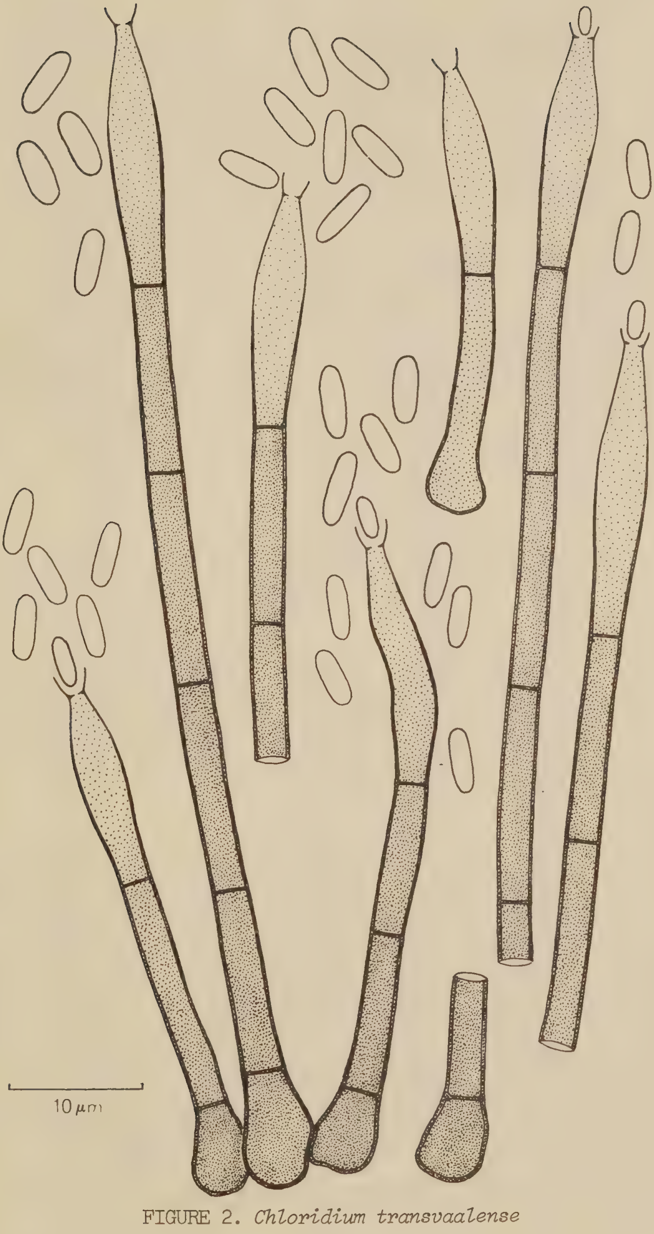

FIGURE 2. *Chloridium transvaalense*

leniter flexuosa, septata, brunnea, laevia, apicem versus ramosa, usque ad 180µm longa, 8 - 10µm crassa, basi interdum ad 14µm inflata. Cellae conidiogenae monotreticae, discretae vel in conidiophoris et in ramis incorporatae, cylindricae vel anguste clavatae, brunneae vel pallide prenneae, 16 - 24 X 6.5 - 9µm. Conidia plus ellipsoidea vel obovata, 2 septata, sicca, laevia, brunnea, 28 - 39 X 19 - 22µm.

In ligno emortuo, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotypus.

Colonies effuse, brown to black, hairy, somewhat sparse. Mycelium immersed in the substratum, composed of branched, septate, pale brown to brown, smooth, 2 - 3µm wide hyphae. Conidiophores macronematous, mononematous, arising singly, terminally and laterally on the hyphae, erect, straight or slightly flexuous, septate, brown, smooth, branched towards the apex, up to 180µm long, 8 - 10µm wide, swollen to 14µm at the base. Conidiogenous cells monotretic, discrete or integrated in the conidiophore, cylindrical or narrowly clavate, occasionally slightly doliiform or, if located terminally on the main conidiophore stipe, sometimes subglobose, partly as a result of constriction at the delimiting septum, brown to pale brown, usually slightly paler when discrete, 16 - 24 X 6.5 - 9µm. Conidia solitary, acrogenous, simple, more or less ellipsoidal or obovate, 2-septate, dry, smooth, brown, 28 - 39 X 19 - 22µm.

On dead wood; South Africa.

Collection examined: on dead decorticated wood, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotype.

Dendryphiopsis biseptata is distinct in its morphology, particularly that of its conidia, from all three species presently accepted in *Dendryphiopsis* Hughes, namely *D. atra* (Corda) Hughes, the type species, *D. arbuscula* (Berk. and Curt.) Hughes and *D. fascicularis* (Berk. and Rav.) Hughes. These have been previously redescribed in detail by Morgan-Jones (1974a, 1974b). It comes closest to *D. atra* in the morphology of its conidiophores.

Guedea ovata sp. nov. (Fig. 4).

Coloniae effusae, brunneae vel atrae, sparsae. Mycelium in substrato immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus, 2 - 3µm crassis compositum. Conidiophora macronemata, mononemata, ex apice lateribusque hypharum oriunda, simplicia vel ad basim ramosa, erecta, recta vel leniter flexuosa, cylindrica, apice obtusa, laevia, septata, acroauxica, indeterminata, pallide brunnea vel brunnea, usque ad 370µm longa, 4 - 5µm crassa; basim versus cellae 8 - 15µm longae, apicem versus gradatim breviores ad 4 - 8µm longae. Cellae conidiogenae holoblasticae, monoblasticae, in conidiophoris incorporatae, leniter denticulatae. Conidia solitaria, sicca, in denticulis successivis oriunda, ovata, ad septis leniter constricta, laevia, 2 septata, 15 - 16.5 X 8 - 9µm; cellulae superiorae pallide brunneae, cellula basalis brunnea et poris germinationibus praedita.

In ligno emortuo, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotypus.

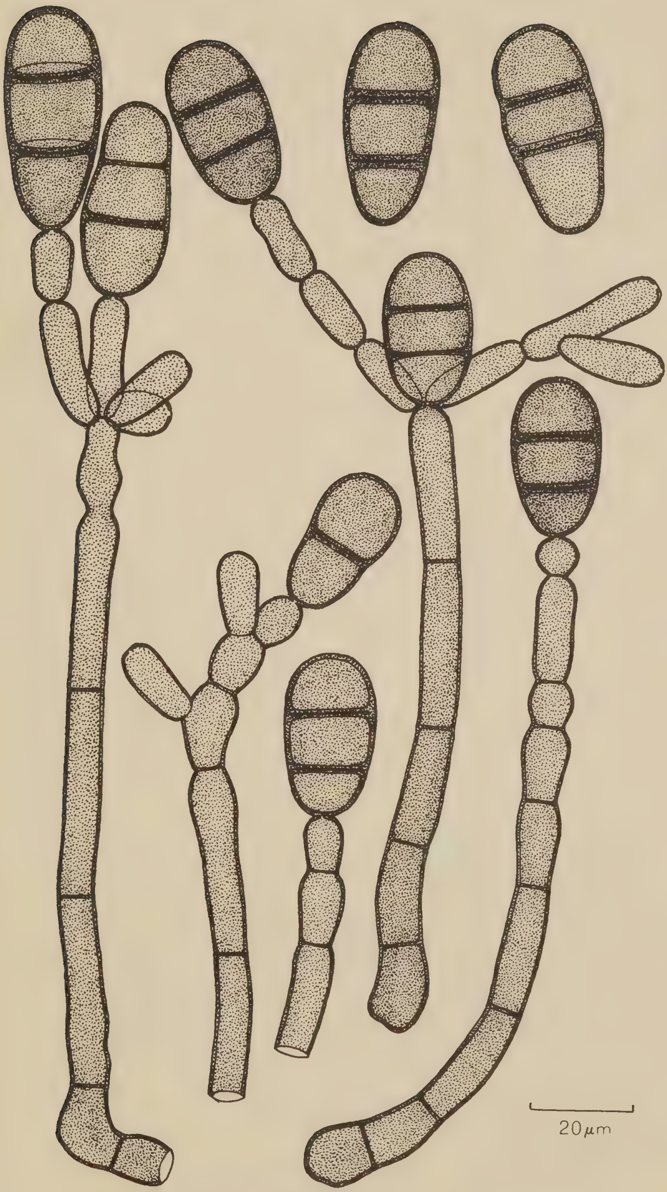

FIGURE 3. *Dendryphiopsis biseptata*

Colonies effuse, brown to black, sparse. Mycelium mostly immersed in the substratum, sometimes in part superficial, composed of branched, septate, pale brown, smooth, 2 - 3µm wide hyphae. Conidiophores macronematous, mononematous, arising terminally and laterally on the hyphae, simple or branched at the base, erect, straight or slightly flexuous, cylindrical, apex obtuse, smooth, septate, acroauxic, indeterminate, pale brown to brown, with the extreme apex, where meristematic activity continues indefinately, subhyaline and thin-walled, up to 370µm long, 4 - 5µm wide; cells towards the base 8 - 15µm long, gradually becoming shorter, 4 - 8µm long, towards the apex, with sometimes groups of shorter cells also present in intermediate positions. Conidiogenous cells holoblastic, monoblastic, integrated, slightly denticulate. Conidia solitary, dry, formed successively on short denticles, ovate, 2-septate, slightly constricted at the septa, smooth, 15 - 16.5 X 8 - 9 µm; with the two upper cells pale brown and the basal cell brown, bearing an easily discernible, thin, germ pore-like area in the wall basally and sub-basally.

On dead wood; South Africa.

Collection examined: on dead decorticated wood, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotype.

Guedea ovata is closely similar to the other two species of *Guedea* Rambelli and Bartoli previously described, namely *G. sacra* Rambelli and Bartoli, the type species, and *G. novae-zelandiae* Hughes, in its conidiophore characteristics. A solitary conidium is produced from each conidiogenous cell delimited progressively by indeterminate meristematic extension in the apical region. Conidiogenous loci are located immediately below transverse septa delimiting each conidiogenous cell but not every cell in the terminal part of the conidiophore is necessarily fertile as evidenced by the presence of a denticle indicating point of conidium attachment. Conidiation is usually initiated in a penultimate cell or the one immediately below it, but very occasionally a conidial primodium is apparent in the ultimate cell before the full differentiation of a delimiting septum, or even its initiation. Conidiophore denticles are short, so much so in some instances as to be not easily discernible.

The conidia of *G. ovata* serve to distinguish it easily. Unlike those of *G. sacra* and *G. nova-zelandiae* they are rather pale in color, more broadly ovate, slightly constricted at the septa, without dark transverse bands, and bearing no obvious basal scar. They are of a similar size to those of *G. novae-zelandiae*, being somewhat shorter than those of *G. sacra*. A thin area in the wall of the basal cell is evident but it is not clear whether this coincides the the point of attachment Hughes (1980) and Wang and Sutton (1982) report thin areas in the wall of all three cells of *G. novae-zelandiae* and Hughes (1980) noted the presence of a terminal thin wall area in the apical cell of *G. sacra* conidia, interpreting it as being possibly a germ pore.

Melanocephala triseptata (Shearer, Crane and Miller) Hughes, N.Z. Jl. Botany 17: 171, 1979 (Fig. 5).

≡ *Endophragmiella triseptata* Shearer, Crane and Miller, Mycologia 68: 184, 1976.

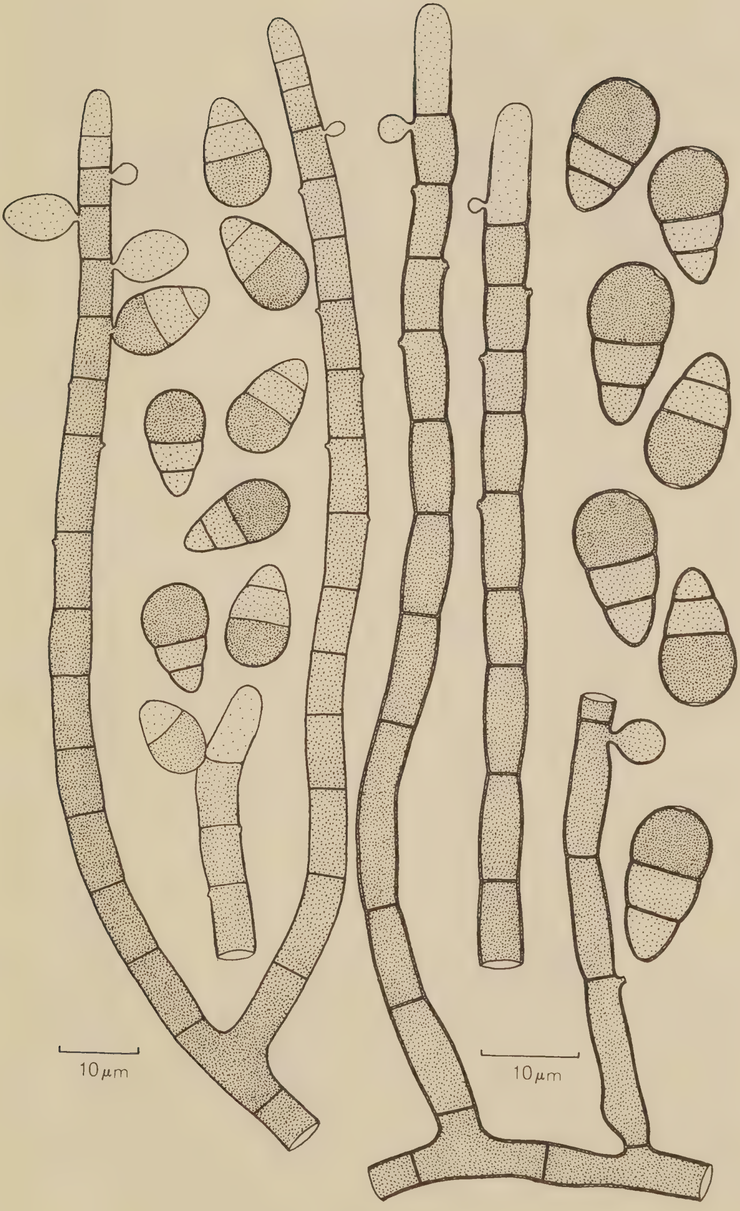

FIGURE 4. *Guedea ovata*

Colonies broadly effuse, black, hairy. Mycelium mostly immersed in the substratum, composed of branched, cylindrical, smooth, septate, subhyaline to pale brown, 2 - 3.5um wide hyphae. Conidiophores macronematous, mononematous, solitary or in a loose fascicle of a few, erect, simple, straight or very slightly flexuous, septate, smooth, proliferating percurrently a number of times, mid brown, becoming paler towards the apex, especially following proliferation, slightly bulbous at the extreme base, up to 150µm long, 5 - 6µm wide, swollen to 7 - 9.5 µm wide at the base. Conidiogenous cells monoblastic, integrated, terminal, cylindrical, frequently broadened slightly distally. Conidia broadly ellipsoidal or obovoid, brown to dark brown, 3-septate, with broad, dark brown to black bands masking the upper two septa, smooth, obtuse at the apex, truncate at the base, seceding rhexolytically, bearing a very narrow basal frill, 23 - 31 X 13 - 18µm, 5 - 6µ wide at the base.

On dead wood and stems; Taiwan, South Africa and North America.

Collection examined: on dead decorticated wood, Debengeni Forest Reserve, Magaebaskloof, N.E. Transvaal, South Africa, August 17, 1979, R.C. Sinclair, AUA.

Melanocephala triseptata was described by Shearer, Crane and Miller (1976) from collections made in Illinois, U.S.A., on decayed wood submerged in swamp water. It was reported to occur in Taiwan by Matsushima (1980).

Paradendryphiopsis anomala sp. nov. (Fig. 6).

Coloniae effusae, fuscae vel atrae, pilosae. Mycelium in substrato immersum, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, laevibus, 2 - 4µm crassis compositum. Conidiophora macronemata, mononemata, singula ex apice lateribusque hypharum oriunda, erecta, recta vel leniter curvata, cylindrica, simplicia, septata, brunnea, laevia, usque ad 230µm longa, 5 - 9µm crassa. Cellae conidiogenae holoblasticae, monoblasticae, in conidiophoris incorporatae. Conidia solitaria, sicca, ellipsoidea, laevia, 3 - 4 septata, cellulis extimis pallide brunneis, cellulis intermediis brunneis, 24 - 26 X 11 - 13µm.

In ligno emortuo, Maierpskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotypus.

Colonies effuse, dark blackish brown to black, hairy. Mycelium immersed in the substratum, composed of branched, septate, pale to mid brown, smooth, 2 - 4µm wide hyphae. Conidiophores macronematous, mononematous, arising singly, terminally or laterally on the hyphae, erect, simple, straight or curved, cylindrical, brown, smooth, up to 230µm long, 5 - 9µm wide, sometimes slightly bulbous at the base to 13µm, 2.5 - 3µm ib diameter at the extreme apex where onlt the inner wall remains after conidium detachment. Conidiogenous cells holoblastic, monoblastic, terminal, integrated. Conidia solitary, dry, ellipsoid, smooth, 3 - 4-septate, brown, with the outer cells paler, usually slightly constricted at the end septa, seceding schizolytically, 24 - 26 X 11 - 13µm.

On dead wood; South Africa.

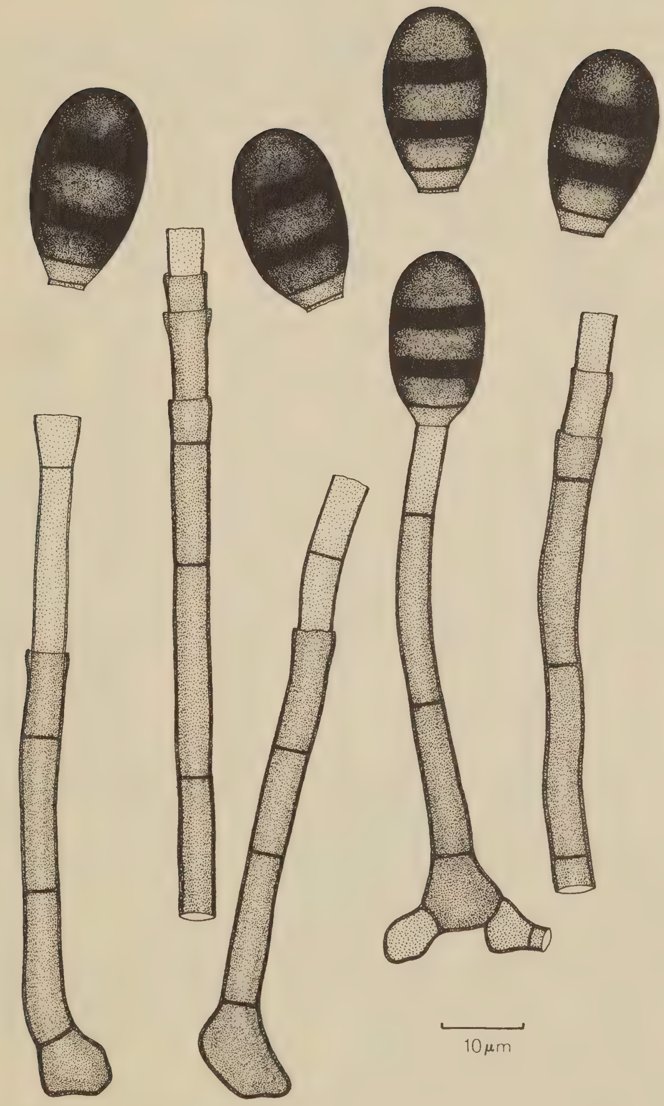

FIGURE 5. *Melanocephala triseptata*

Collection examined: on dead decorticated wood, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotype.

The conidiogenous cells of *Paradendryphiopsis* M.B. Ellis, type species *P. cambrensis* M.B. Ellis, were originally described by Ellis (1976) as being monotretic. Hughes (1979), however, when adding a second species, *P. laxa* (Hudson) Hughes [≡ *Endophragmia laxa* Hudson], to the genus considered them to be blastic rather than tretic since a continuity is evident between the wall of the conidiogenous cell and that of the conidium. Following schizolytic conidium secession the thin inner wall at the apex of the conidiogenous cell (that is, the half septum left behind) becomes evident over the area of conidium attachment. This inner wall frequently assumes a concave aspect following conidium release.

Paradendryphiopsis anomala, as the name indicates, deviates from the other two species in possessing unbranched conidiophores and noncatenate conidia.

Parasympodiella africana sp. nov. (Fig. 7).

Coloniae effusae, fuscae, breviter pilosae. Mycelium superficiale et immersum, ex hyphis, ramosis, septatis, brunneis, laevibus, 2.5 - 3.5 µm crassis compositum. Conidiophora macronemata, mononemata, singula ex lateribusque hypharum oriunda, simplicia, erecta, recta, apicem versus pallidiora et tenuiora, laevia, brunnea vel pallide brunnea, septata, cylindrica, usque ad 65µm longa, 2 - 3µm crassa. Cellulae conidiogenae holothallicae, in conidiophoris incorporatae, terminales vel intercalares, indeterminatae, irregulariter sympodiales, laeves, geniculatis, ad apices conidiis formatae. Conidia solitaria, sicca, cylindrica, shizogena, recta, hyalina, laevia, 3 - 4 septata, ad basim truncata, ad apicem obtusa, 31 - 33 X 2µm.

In foliis emortuis, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotypus.

Colonies effuse, dark brown, shortly hairy. Mycelium partly superficial, partly immersed in the substratum, frequently forming an extensive network, composed of branched, septate, brown, smooth, 2.5 - 3.5 µm wide hyphae. Conidiophores macronematous, mononematous, borne singly and laterally on the hyphae, simple, erect, straight below, geniculate and often with a distinct zig-zag appearance distally, becoming paler and thinner-walled towards the apex, smooth, brown to pale brown, septate, cylindrical, up to 65µm long, 2 - 3µm wide. Conidiogenous cells holothallic, incorporated in the conidiophores, terminal or intercalary, indeterminate, irregularly sympodial, smooth, bearing a conidium at the apex. Conidia solitary, dry, cylindrical, straight, hyaline, smooth, 3 - 4-septate, with a truncate, slightly inflated base, apex obtuse, 31 - 33 X 2µm.

On dead leaves; South Africa.

Collection examined: on unidentified dead leaf from forest leaf litter, Mariepskop, N.E. Transvaal, South Africa, December 1, 1981, R.C. Sinclair, AUA, holotype.

The genus *Parasympodiella* was established by Ponnappa (1975) to

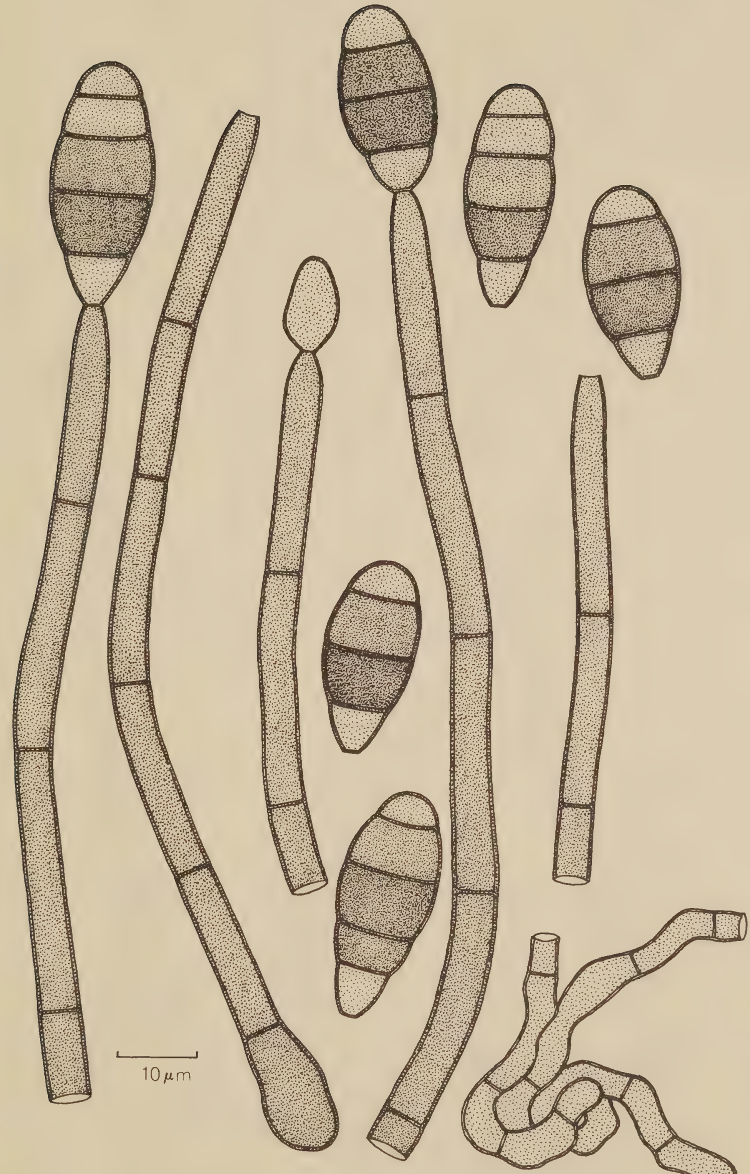

FIGURE 6. *Paradendryphiopsis anomala*

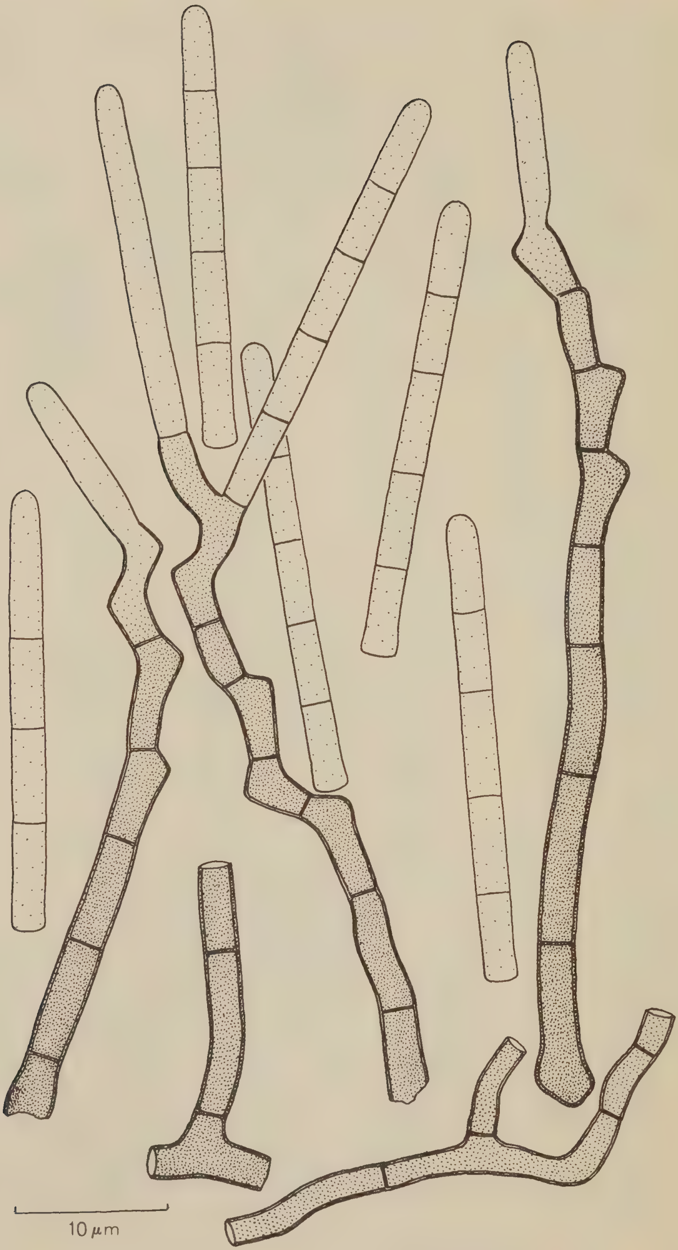

FIGURE 7. *Parasympodiella africana*

accommodate *Sympodiella laxa* Subramanian and Vittal. The fungus was originally described from India (Subramanian and Vittal, 1973), but has subsequently been recorded from Japan (Matsushima, 1975) and Alabama, U.S.A. (Morgan-Jones, 1980). Sutton (1978) added a second species, *Parasympodiella clarkii*, collected in England, to the genus. Possession of sparingly branched, sympodial conidiophores which produce, at irregular intervals, chains of cylindrical, septate conidia bearing punctiform septal plugs, was noted by Ponnappa to be the hallmark of *Parasympodiella*. Septal plugs are not, however, present in *P. clarkii*.

Parasympodiella africana has essentially the same general conidiophore morphology as *P. laxa* but the conidiogenous loci are more closely arranged and are located at more regular intervals. In *P. africana*, as is usually also the case in *P. laxa*, each conidiogenous cell bears but a single flat conidiogenous locus. In the distal portion of the conidiophores of *P. africana* almost all cells are fertile. Where the conidiogenous cell occupies a terminal position several loci may be present at one time but these subsequently become separated as the conidiophore cell elements are successively delimited. *Parasympodiella clarkii* differs from both *P. laxa* and *P. africana* in having conidiogenous cells that frequently bear several loci and conidiophores which become annellate following a series of percurrent proliferations.

Apart from differences in details of conidiophore morphology and conidial dimensions *P. africana* can be distinguished from the other two species by lack of conidium catenation. In this regard it bears similarity to *Subulispora* Tubaki which also has conidiophores of similar morphology. The conidia of species of that genus, with the exception of those of *S. hareae* Sutton, which are more or less cylindrical and obtuse at the apex, are, however, distinctly subulate and acute at the apex. Conidiogenous cells in *Subulispora* also bear multiple generative loci.

ACKNOWLEDGMENT

We thank Dr. C.J.K. Wang, State University of New York at Syracuse, for reviewing the manuscript.

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TYPE STUDIES ON SEVERAL AGARICS DESCRIBED BY F. W. JUNGHUHN

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Summary

The holotypes of three agarics described by F.W. Junghuhn (1830) were studied. Evidence is presented for the following taxonomic relations:

Agaricus lugens Jungh. is a synonym of Hebeloma crustuliniforme (Bull.: Fr.) Quél. ss. lato; Agaricus carneoviolascens Jungh. is a synonym of Lepista nuda (Bull.: Fr.) Cooke; Agaricus sterilis Jungh. is a synonym of Inocybe geophylla (Sow.: Fr.) Kummer var. violacea Pat.

Franz Wilhelm Junghuhn (1809 - 1869) is known to the mycologists chiefly by his botanical and mycological investigations at Java (see Schmid 1929, Stafleu & Cowan where further literature is cited). However, when he yet studied at the University of Halle, he was already quite active in the field of agaric taxonomy. Later on he entered the University of Berlin. In 1830, during his stay in Berlin, descriptions of 25 new taxa of fungi were published by him in Linnaea.

Schmid reports on a mycological herbarium consisting of 320 specimens collected by Junghuhn. It belonged to the botanist D.F.L. Schlechtendahl, who was custodian at the Royal Herbarium of Berlin at that time. In 1833 Schlechtendahl moved to Halle. Since that time Junghuhn's herbarium was in Halle where it was discovered by Schmid more than 50 years ago. Unfortunately it was incomplete, but a list of all specimens had been made by Junghuhn which is still at hand. During the following decades, the stock diminished again so that a considerable number of specimens yet seen by Schmid is not discoverable for the time beeing.

Schmid already stated that some of the fungi described by Junghuhn (1830) are kept in this mycological herbarium. He compared the descriptions given in Linnaea with those on the labels of the exsiccata. In this way he was able to identify several of the specimens as belonging to species described by Junghuhn as new. Furthermore, Schmid ascertained that most of the specific names of Junghuhn, the type specimens of which were discovered by him, were treated as synonyms by the mycological authors (e.g. Fries 1836-1838, 1874). So he attached the names as synonyms to other taxa, in most cases corresponding with Fries. However, Fries and other mycologists obviously misinterpreted a considerable number of species described by Junghuhn. Therefore we take trouble to determine the mycological material yet present as well as possible, in order to clear up the identity of the specimens respectively their synonymic relations to other taxa.

The three specimens the present paper deals with must be regarded as holotypes. They are preserved in the Herbarium of the University of Halle/DDR (HAL).

Agaricus lugens Junghuhn

The description of Junghuhn (1830, p. 399):

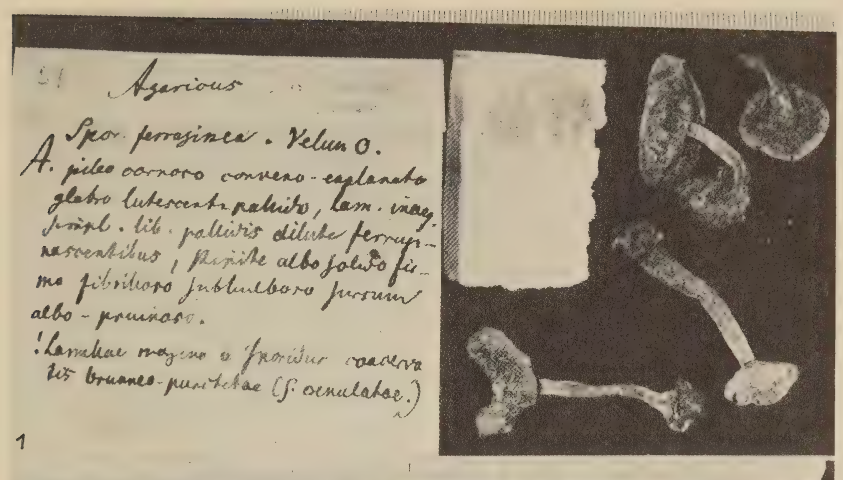
"10. A. LUGENS mihi. Sporidiis ferrugineis, velo/ nullo, pileo carnoso convexo- explanato testaceo- pallido/ glabro, lamellis subliberis pallidis dein brunnescentibus,/ margine fusco- punctato, stipite solido striato albo basi in-/ crassato sursum albo-/ pruinoso.

Socialis. Pileus 2-3 unc. latus, laevis, sub lente/ areolato- striatus, e brunneo- expallens, sublutescens. Caro/ mollis alba. Lamellae simplices, inaequales, leviter ad-/ nexae s. liberae, apice acutae 2 lin. circiter latae, mar-/ gine (a sporidiis) ferrugineo- maculato s. crenulato. Sti-/ pes 3-4 lin. crassus, 2-3 uncias longus; striatus l./ fibrillosus, fibrillis stipite homogeneis, concretis, sursum/ albo- farinaceus s. flocculosus, basi subbulbosus. Odor/ subalcalinus. Velum non vidi, licet permulta individua/ vix e terra emersa, capitulum aciculae referentia, per to-/ tum constantiae suae tempus, exploraverim.

In sylvaticis montosis Hercyniae inf. Septbr."

Junghuhn's herbarium contains a collection with the following text on the label (Fig. 1):

"Agaricus/ Spor. ferruginea. Velum O./ A. pileo carnoso convexo- explanato/glabro lutescente pallido, lam. inaequ./ lib. pallidis dilute ferrugi-/ nascentibus, stipite albo solido fir-/ mo fibrilloso subbulboso sursum/ albo-



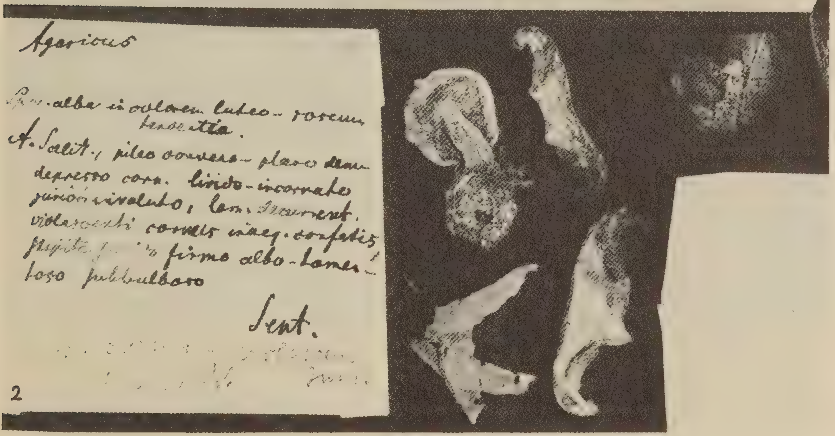
Agaricus

A. Spor. ferruginea. Velum 0.

A. pileo carnoso convexo-explanato glabro lutescente pallido, lam. inaeq. simpl. lib. pallidis dilute ferruginascentibus, stipite albo solido firmo fibrilloso subbulboso sursum albo-pruinoso.

! Lamellae majusc. e sporidiis coacervatis brunneo-punctatae (S. oculatae.)

1



Agaricus

Spor. alba in colorem luteo-roseum tendentia.

A. Solit., pileo convexo-plano demum depresso carn. livido-incarnato juniori involuto, lam. decurrent. violascenti carneis inaeq. confertis, stipite [illegible] firmo albo-lanu-loso subbulboso

Sent.

2

Fig. 1: Holotype of Agaricus lugens Junghuhn (above)

Fig. 2: Holotype of Agaricus carneoviolascens Junghuhn

pruinoso./ ! Lamellae margine a sporidiis coacerva-/ tis brunneo- punctatae (s. crenulatae)"

This collection must be considered as holotype of *Agaricus lugens*. It consists of four fruitbodies, the one of which obviously was collected in early stage. It shows yellowish brown colours (fig. 1, see fruitbody facing the lower right corner), whereas the remaining fruitbodies are brown to dark brown. Spore print rusty- brown. Microscopical features: Spores variable in shape and size, ellipsoid often amygdaliform- limoniform, distinctly warty, (9,0-) 10,5- 12,8/5, 8-8,0 µm. Basidia (probably not completely swollen up to the original size) about 23- 28/ 6-10 µm. Cheilocystidia abundant, about twice as long as the basidias, slender club- shaped, apex 5-8 µm broad.

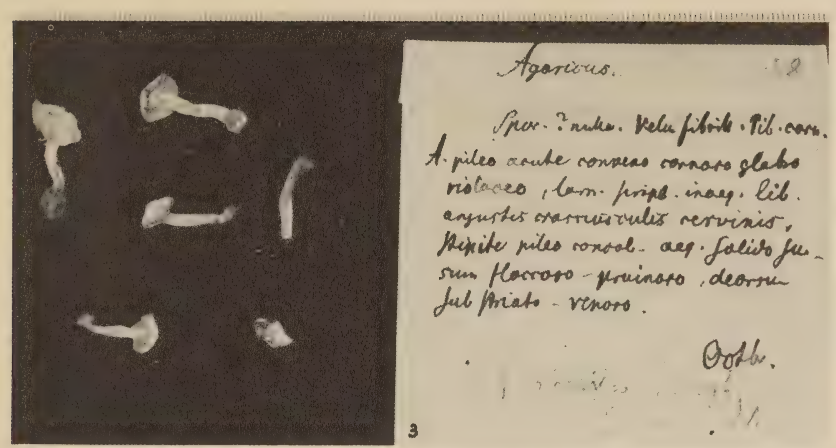
Taxonomic position: *Agaricus lugens* has been regarded as a member of the "tribus" *Hebeloma* by Fries (1836 - 1838, 1874). He arranged the taxon between *A. longicaudus* and *A. truncatus*, two well explicable species of *Hebeloma*. Among other taxa, *A. lubricus* ss. Secretan has been considered as synonym by Fries. Secretan (1833) placed the fungus between *A. balteatus* and *A. longicaudus*. However, it is doubtful whether *A. lubricus* ss. Secretan belongs to *Hebeloma* on the whole. The examination of the authentic material in connection to the description published in Linnaea, shows *Agaricus lugens* Junghuhn being a taxon of the genus *Hebeloma*, belonging to *Hebeloma crustuliniforme* (Bull.: Fr.) Quel. ss. lato. Since the complex of species related to *H. crustuliniforme* is not completely cleared up hitherto, it is not impossible that the name *A. lugens* reaches importance as soon as our knowledge of this difficult group is emended by specialists.

Agaricus carneoviolascens Junghuhn

The description of Junghuhn (1830, p. 398):

"8. A. CARNEO- VIOLASCENS mihi. Sporidiis lutescenti-/ bus, velo nullo, pileo carnoso convexo- plano demum de-/ presso laevi incarnato- testaceo sublivido juniori involuto,/ lamellis adnatis inaequalibus confertis incarnato-violascen-/ tibus, stipite bulboso solido firmo albo-tomentoso.

Solitarius. Sporidia rosea s. alba in colorem roseo-/ lutescentem tendentia, nunc dilutiora, nunc obscuriora./ Pileus 3-4 unc. latus, laevis, epidermide facile sece-/ dente. Stipes 2-2 1/4 unc. longus, 1/2-3/4 unc. crassus,/ in pileum diffusus, e tomento albo villoso-striatus, sub/ villo remoto violascens. Lamellae simplices, inaequales,/ serrulatae, arcuatae, juniores hamatae, apice attenuatae,/ proprie liberae, sed ob stipitis formam diffusam spurie/ adnatae s. decurrentes. Caro pilei stipitisque firma, am-/ bitu subviolascens. Sapor dulcis.



Agaricus.

Spor. ? nuda. Velu fibrill. Pil. carn.
A. pileo acute convexo carnoso glabro
violaceo, lam. propt. inaeq. lib.
angustis crassiusculis cervinis,
stipite pileo concol. aeq. solido sur-
sum flocoso - pruinoso, deorsum
sub striato - venoso.

Oosth.

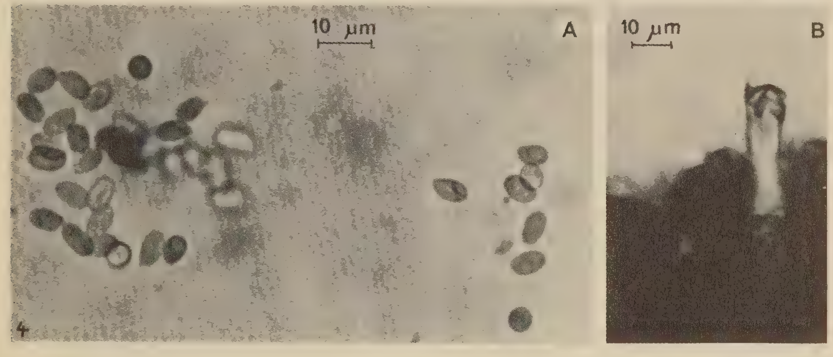


Fig. 3: Holotype of Agaricus sterilis Junghuhn (above)

Fig. 4: A-Holotype of Agaricus carneoviolascens Junghuhn spores. B-Holotype of Agaricus sterilis Junghuhn, cystidium

Crescit in sylvis Hercyniae frondosis. Octbr."

Junghuhn's herbarium contains a collection supplied with the following short description (Fig. 2):

"Agaricus/ Spor. alba in colorem luteo- roseum/ tendentia./ A. solit., pileo convexo- plano demum/ depresso carn. livido- incarnato/ juniori involuto, lam. decurrent./ violascenti- carneis inaeq. confertis,/ stipite solido firmo albo- tomen-/ toso subbulboso/ Sept."

This collection must be considered as holotype. It is composed of some longitudinal sections of a large fruitbody, a little one, and two spore prints on small sheets of paper. The fruitbodies are in a bad condition because of being disfigured by mould. The thickening of the stem base partially consists of particles of substratum penetrated by mycelium threads. Cup and stipe dingy dark brown, gills brown, flesh paler brown. Microscopical features: Spores ellipsoid in ventral and dorsal view, attenuated towards the hilar appendix in lateral view, round in apical view, thin- walled and distinctly warty, 6,7-9,1/3,8-5,5 µm (Fig. 4 A). Basidia tetrasporic, not swollen up to the original shape and size. Cystidia not seen. Lamellar trama regular.

Taxonomic position: The name Agaricus carneoviolascens Junghuhn is mentioned by only few mycologists. Fries (1832, p. 11) cites the taxon as follows: "carneoviolascens Jungh. (personat.?) Linn. V. 398." Consequently he thought A. carneoviolascens possibly being A. (Tricholoma) personatus. Later on (Fries 1836-1838, 1974) he equated the fungus to A. (Clitocybe) tyrianthinus Fr. The latter taxon is known merely by Fries. Authors engaged in this group of agarics exclusively rely on the description given by Fries (see Ricken 1915, Nüesch 1926, Kühner & Romagnesi 1953: ".. est très probablement un Rhodopaxillus.."). The descriptions of Fries demonstrate that A. tyrianthinus is a fungus apparently very similiar to Lepista nuda. The microscopical features as well as the description of Junghuhn suggest the conclusion that Agaricus carneoviolascens Junghuhn must be treated as a synonym of Agaricus nudus Bull.: Fr. = Lepista nuda (Bull.: Fr.) Cooke.

Agaricus sterilis Junghuhn

The description of Junghuhn (1830, p. 404):

"19. A. STERILIS mihi, Sporidiis nullis, velo fibrilloso,/ pileo carnoso acute convexo glabro violaceo, lamellis li-/ beris angustis crassiusculis brunneis, stipite aequali solido/ violaceo sursum pruinoso basi substriato. Tab. VI. f. 8.

Elegans. Velum fibrillosum, fugax. Sporidia non/ vidi,

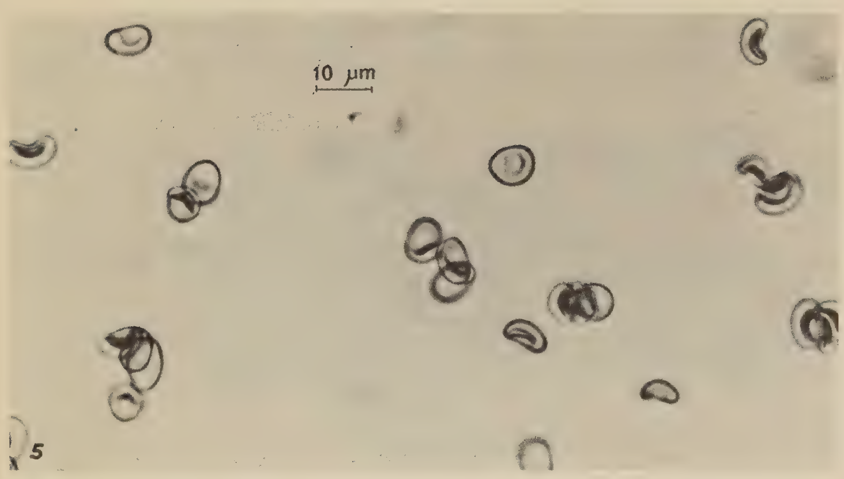


Fig. 5: Holotype of Agaricus sterilis Junghuhn, spores

licet haud exiguam individuorum copiam chartae im-/ posuerim! Pileus convexus, acutus, (subumbonatus,) un-/ ciam circiter latus, carne alba. Lamellae simplices, in-/ aequales, crassae, subliberae, utrinque aequaliter attenua-/ tae, dorso rectae, brunneae, cervinae, lineam, vix ultra,/ latae. Stipes 2 lin. crassus, 1-1 1/2 unc. longus, apice/ floccoso- pruinatus, deorsum e venis homogeneis substria-/ tus. Odor saporque nulli.

Inv. solitarium in sylvis Hercyniae inf. ad Harzgerode,/ Falkenstein, passim. Septbr. - Octbr.

Ag. geophyllus Bull. P. longe alius."

Junghuhn's herbarium contains a collection with the following short description (Fig. 3):

"Agaricus./ Spor.? nulla. Velum fibrill. Pil. carn./ A. pileo acute convexo carnoso glabro/ violaceo, lam. simpl. inaeq. lib./ angustis crassiusculis cervinis,/ stipite pileo concol. aeq. solido sur-/ sum floccoso- pruinoso, deorsum substriato- venoso./ Octbr."

This collection must be regarded as holotype. It consists of four fruitbodies. Although Junghuhn said the fruitbodies to be sterile, we found brown spores in mass in the microscopic slide. (We suppose that Junghuhn used no microscope in checking up all the species published in Linnaea. He merely examined the colour of the spore powder by means of spore prints. On the plates coloured spots represent the colour of the spore powder.) Cup and stem are orange brown to reddish ochraceous, with greyish tint because of being covered with hyphae. Microscopical features: Spores 8,5-9,4/5,5-6,5 µm (Fig. 5). Cystidia abundant, lageniform, apex often slightly inflated, thick-walled often crested, 50-75/12-15 µm, neck 7-9 µm broad (Fig. 4 B).

Taxonomic position: Fries adopted the name A. sterilis in 1832 and 1874. In 1832 he mentioned the agaric as "sterilis et am. nig.", and in 1874 he cites it as an independent taxon, viz. Agaricus (Hebeloma) sterilis. The coloured figure (Junghuhn 1830, tab. IV, fig. 8) presents a violaceous fruitbody showing the general aspect of Inocybe geophylla, and a longitudinal section with white flesh and brown gills. This figure as well as Junghuhn's description and the microscopical data demonstrate that Agaricus sterilis Junghuhn is a synonym of Inocybe geophylla (Sow.: Fr.) Kummer var. violacea Pat.

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OCHOTRICHOBOLUS POLYSPORUS, A NEW GENUS AND SPECIES OF OPERCULATE DISCOMYCETES (PEZIZALES)[1]

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SUMMARY

Ochotrichobolus polysporus is described as a new genus and species of coprophilous discomycetes (Pezizales) resembling the genera Lasiobolus, Trichobolus, and Cheilymenia, differing in having hairs with buttresses or prop roots. Its taxonomic position is discussed.

Approximately 20 genera of operculate discomycetes are known to be coprophilous. Fifteen of these genera have hyaline spores, eight genera have at least some species with multispored asci, and five genera have setose apothecia (Kimbrough 1972). A recent collection by Nina Shishkoff, a graduate student at Cornell University, of a small, setose, coprophilous discomycete with hyaline spores and multispored asci led us initially to believe that we had encountered a species of one of the genera of the Thelebolaceae. Its multispored asci were remarkably similar to those of Lasiobolus cainii Kimbr., but unlike Lasiobolus the setae were consistently septate, as are those in Trichobolus.

Specimens were mounted in Melzer's Reagent (iodine) to determine blueing and dextrinoid reactions, in lacto-phenol cotton-blue for a cyanophilic reaction, and in Congo red for ascal and excipular staining properties. Specimens stained in 1% aqueous Congo red were destained in 2% aqueous KOH and mounted in 50% aqueous glycerine. Unfixed, dried herbarium material was prepared for scanning electron microscopy (Benny, Samuelson, and Kimbrough 1980) by gold coating with a Hummer Jr. sputter coater and photographed with a Hitachi S450 scanning electron microscope.

Critical examination of apothecia revealed, however, that although ascal spore number, hair septation, and other features were reminiscent of those in Lasiobolus and Trichobolus, the presence of prop roots and rooting hairs appear unique for the operculate discomycetes. For this taxon we propose a new genus and species:

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OCHOTRICHOBOLUS POLYSPORUS gen. et sp. nov. Figs. 1-12

A Lasiobolo pilis septatis, a Trichobolo ascis operculatis, ab ambobus generibus pilis tantem ad marginem praesentibus et anteridibus ad bases pilorum formatis recedit.

HOLOTYPUS: N. Shishkoff, on dung of small animal and on surrounding wood, C. L. Pack Demonstration Forest, Warrensburg, New York, 11. IX. 1982 (CUP 59844).

DIAGNOSIS: Differing from Lasiobolus by septate hairs, from Trichobolus by operculate asci, and from both genera by having hairs present only at the margin and by forming buttresses at the bases of the hairs.

DESCRIPTION: Apothecia scattered, sessile, discoid to cupulate, 0.2-0.5 mm in diam, white to yellowish, with prominent marginal hairs. Setae septate, hyaline, arising from marginal cells of the excipulum, of two types, one of long, bristly, acute hairs 120-130 µm long with 14 to 16 septa and another of short, somewhat flexuous, pointed hairs, 25-42 µm long with 2 to 3 septa. Both long and short hairs with deeply staining roots that extend 4 to 5 cells within the excipulum. Short hairs adjacent to each long hair are appressed to it and appear as prop roots. Ectal excipulum of one layer, cells of a textura angularis, 10-15 x 15-25 µm, horizontally oriented, with each marginal cell bearing either a long or a short hair. Medullary excipulum of a textura angularis to textura globulosa, cells 15-20 x 20-25 µm in diam, 2 to 4 layers thick, hyaline and thin-walled. Asci cylindric, operculate, containing approximately 128 spores, dome-shaped at the apex, attenuated below, staining unformly in Congo red, 165-190 µm long, 20-25 µm broad. Ascospores hyaline, one-celled, thin-walled, smooth, uninucleate, devoid of oil guttules and of deBary bubbles, 4.0-4.2 x 7.0-8.4 µm. Paraphyses filiform, simple, septate, reaching 3.0 µm in width at their apices, extending slightly beyond the asci.

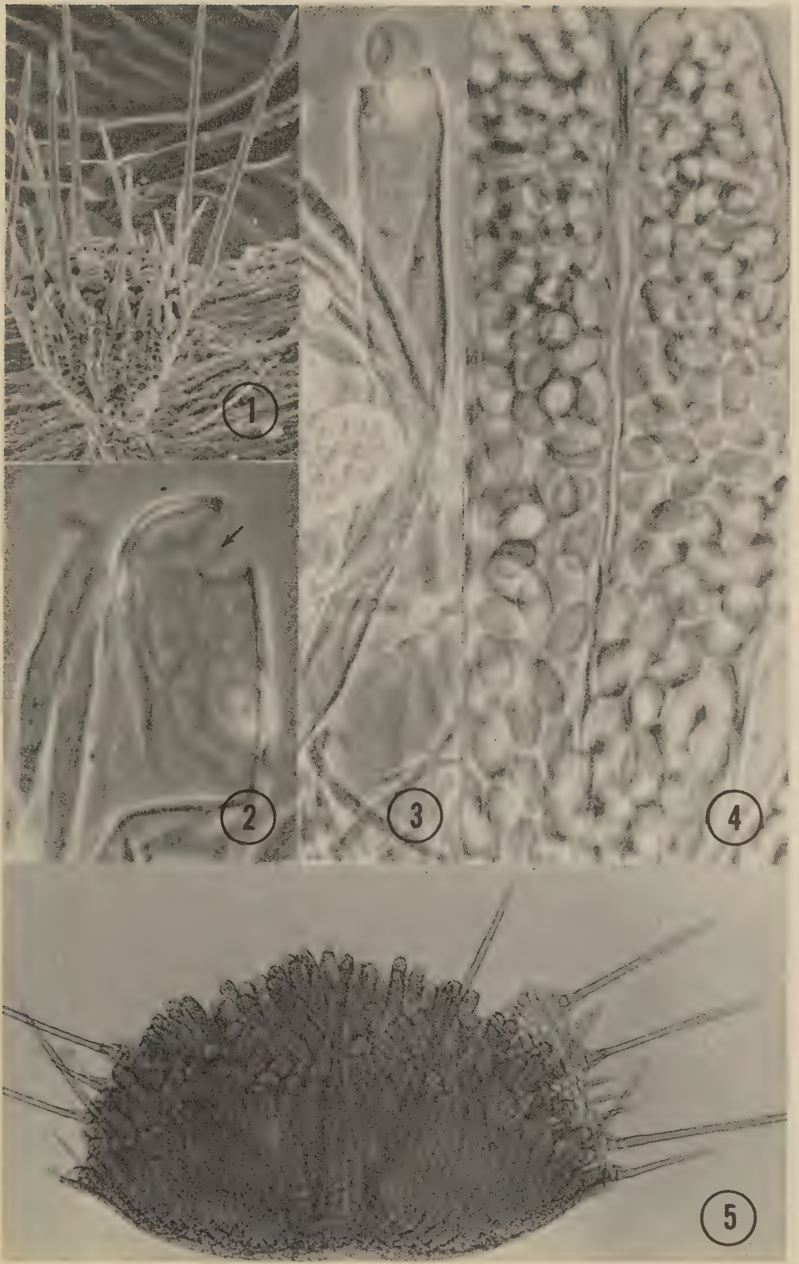
HABITAT: On unidentified dung attached to wood.

NAME: Greek, ocho, prop or support, + Trichobolus, generic name of allied genus.

SPECIMEN EXAMINED: Holotype, CUP 59844.

COMMENTS: Ochotrichobolus polysporus shares a number of features with other coprophilous, operculate discomycetes. The small, setose apothecia with hyaline hairs (Figs. 1, 5, 11) are similar to those of species of Lasiobolus and Trichobolus. Setae in O. polysporus, however, are septate (Fig. 11) but unique in that there is a single row of hairs only on the marginal cells of the excipulum (Fig. 6). Moreover, each long hair has two closely appressed prop hairs at the base (Figs. 6, 7, 12). Between each long hair with its prop roots (buttresses), from 1 to 4 individual, short, flexuous hairs are found (Figs. 6, 7, 9). Both short and long hairs have a narrower, rooting base that is deeply stained in Congo red (Fig. 7). In

FIGS. 1-5. **Ochotrichobolus polysporus**. 1. Scanning electron micrograph of apothecium on dung, x 150. 2. Apex of an ascus showing dome-shaped operculum and thin dehiscence zone in the ascus wall (arrow), x 1000. 3. Cylindric, operculate ascus, x 500. 4. Two multispored asci, x 1000. 5. Squash mount of apothecium showing numerous multispored asci, thin excipulum, and marginal hairs, x 150.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squash mounts these rooting hyphae appear to be growing within the excipular cells (Figs. 6, 7). Scanning electron micrographs (Figs. 11, 12) reveal that they are on the outside of the excipular cells and tend to be inserted into the excipulum a few cells below the hair base. While hairs in species of Trichobolus are similarly hyaline and multiseptate, their manner of attachment is quite different (Kimbrough and Korf 1967; Krug 1973). Hairs in most species of Lasiobolus are non-septate and ventricose towards their bases (Bezerra and Kimbrough 1975). One exception is found in L. monascus Kimbr. in which setae toward the apex of the apothecium are large, ventricose, and non-septate while the smaller, lateral setae are sometimes septate (Kimbrough 1974). Here, too, the setae are devoid of rooting hyphae.

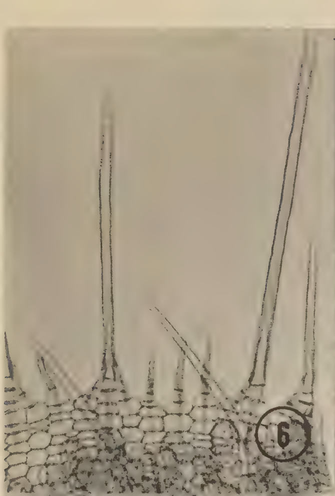
While rooting hairs have been found in a number of species of Cheilymenia, those are deeply pigmented and appear to originate deep within the tissue of the excipulum and neither taper nor run along the surface of the excipulum as do those of O. polysporus. A universal, and diagnostic, feature of the genus Cheilymenia is the manner in which the outermost wall of the ascospore separates and becomes detached when heated in lactic acid. This is not true in Ochotrichobolus.

The excipulum of O. polysporus is also unique in that the marginal ectal excipulum is composed of only a single layer of cells (Fig. 8). The uniform radial and horizontal arrangement of excipular cells in Ochotrichobolus is somewhat approached in a few species of Lasiobolus (Bezerra and Kimbrough 1975), but is distinctly different in Trichobolus and in Cheilymenia.

Multispored operculate asci have also been found in Lasiobolus, Coprotus, and Thecotheus. Coprotus and Thecotheus, however, are easily distinguished in that both have glabrous apothecia. Thecotheus has iodine positive asci and thickwalled ascospores, and Coprotus is gymnohymenial in development. While the exact number of spores in Ochotrichobolus was not determined, more than 120 spores (likely 128) is found per ascus (Fig. 4). The operculum is distinct, with an obvious thin zone of dehiscence in the dome of the ascus (Figs. 2, 3). The ascospores are thin-walled, hyaline, eguttulate, and smooth under the light microscope (Fig. 4), although with SEM (Fig. 10) they appear verrucose. Wrinkling of the perisporic layer is likely an artifact of fixation for SEM. DeBary bubbles failed to develop in any of the various mounting media used in studying this fungus. In unphotographed studies with phase interference microscopy the spores were found to be uninucleate. Simple, filiform, septate paraphyses with no apparent guttules provide little taxonomically useful information (Fig. 2).

The morphological and anatomical features of Ochotrichobolus are most like those of Lasiobolus and Trichobolus. These genera

FIGS. 6-12. **Ochotrichobolus polysporus.** 6. Portion of ectal excipulum with both short and long marginal hairs, x 200. 7. Congo red-stained margin of excipulum showing short and long rooting hairs, x 1000. 8. Margin of excipulum one cell-layer in thickness, x 1000. 9. Scanning electron micrograph of short hairs showing points of insertion of rooting hyphae, x 1100. 10. Scanning electron micrograph of ascospore showing verrucose surface, x 6200. 11. Septate hair, x 1000. 12. Scanning electron micrograph of long hair with rooting bases and prop roots, x 1100.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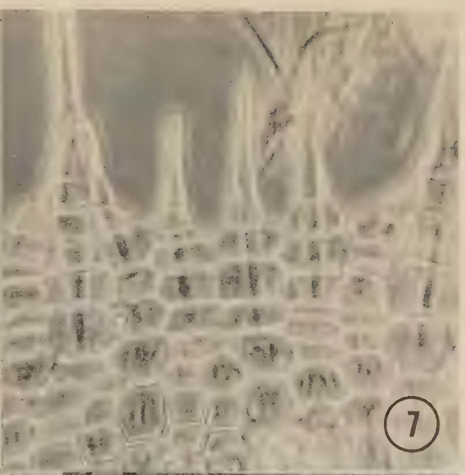
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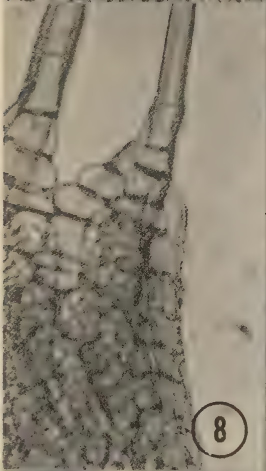
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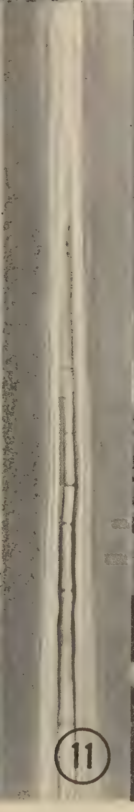
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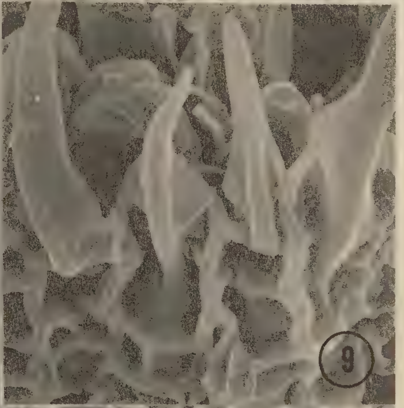
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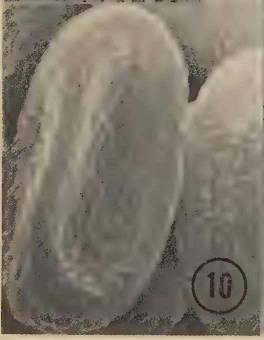
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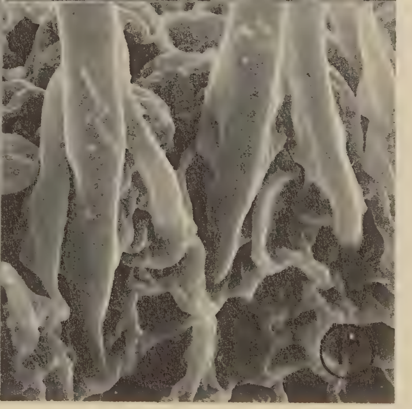

were placed in the tribe Theleboleae (Pezizaceae) by Kimbrough and Korf (1967), a tribe subsequently raised to family rank by Eckblad (1968). While the Thelebolaceae has been recognized by a number of workers (Rifai 1968; Dennis 1968, 1978; Kimbrough 1970, 1982), others have suggested that the family may be an unnatural group. Kish (1974) found that in both structure and development *Coprotus* related to *Pyronema*, and suggested that it be placed alongside it in the Pyronemataceae (sensu Rifai 1968). Conway (1975) also concluded that *Lasiobolus* appears to be more closely related to *Coprobia*, *Scutellinia*, and *Cheilymenia*, and should be considered with them in the Scutellinieae (sensu Korf 1972). In a study of *Thelebolus*, the genus on which the tribe and family names are based, Kimbrough (1981) concluded that the asci are basically the "jack-in-the-box" type, primordial development was atypical of the Pezizales, and septal pore organelles at the ultrastructural level were similar to those found in the Loculoascomycetes.

In light of these studies we suggest that *Ochotrichobolus*, *Lasiobolus*, and *Trichobolus* should be excluded from the Thelebolaceae and considered alongside *Cheilymenia*, *Scutellinia*, and other setose members of the Scutellinieae.

ACKNOWLEDGMENTS

We would like to thank Dr. Gerald L. Benny for taking the SEM micrographs of apothecial structures and Dr. Kenneth Curry for darkroom assistance. Dr. William J. Dress kindly corrected the Latin diagnosis.

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NEW SPECIES OF MICROASCUS AND PETRIELLA (MICROASCACEAE) FROM JAPAN

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SUMMARY

Microascus tardifaciens Horie & Udagawa and *Petriella proteophila* Horie & Udagawa, two new species of the Microascaceae, are described and illustrated.

The Microascaceae Luttrell ex Malloch (1970) are easily recognized by usually less hairy perithecia than in the Chaetomiaceae, irregularly disposed asci without croziers, reddish brown ascospores which are one-celled and dextrinoid when young, and often associated with an anamorph of annelo- or aleurioconidia. According to Benny and Kimbroughs' synopsis of the order and families of Plectomycetes (Benny and Kimbrough, 1980), there are three ostiolate genera, *Lophotrichus*, *Microascus*, *Petriella*, and three cleistocarpus genera, *Enterocarpus*, *Kernia* and *Petriellidium*. Frequently *Pithoascus* (von Arx, 1973, 1978) has been also placed in the Microascaceae. However, due to the such differences as the presence of arthroconidial anamorphs and narrowing fusoid or naviculate ascospores without germ pores, Benny and Kimbrough proposed the Pithoascaceae to accommodate two genera *Pithoascus* and *Faurelina*.

During an ecological investigation of the proteophilous fungi (Sagara, 1975, 1976, 1978, 1979) colonizing the surface of soil after treatments with nitrogenous materials or abandoned animal nests, several members of the Microascaceae were frequently encountered. Amongst them our attention has been drawn particularly to two less common *Microascus*-like isolates with a white *Scopulariopsis* anamorph which were thought to represent undescribed taxa in the Microascaceae. In this paper, both isolates are described and illustrated as new species of the genera *Microascus* and *Petriella* respectively.

Microascus tardifaciens Horie & Udagawa, sp.nov. (Figs. 1, 3-8)
Stat. anam. *Scopulariopsis tardifaciens* Horie & Udagawa, anam.-sp.nov.

Coloniae in agaro farina avenae mixto restrictae, planae, tenues, e mycelio vegetativo submerso compositae, albae vel olivaceo-griseae; perithecia abunde producentia, cum hyphis aeriis funiculosis et conidiis laxe circumnexa; reversum incolor vel cano-stramineum.

Perithecia semi-immersa vel fere superficialia, dispersa vel

aggregata, nigra, ampulliformia, ad basim 160-265 µm diam, glabra, lente matura; collum nigrum, cylindraceum, 115-185 x 35-40 µm, pilosum; pili hyalini vel dilute flavo-brunnei, recti vel sinuosi, nonramosi, leves, remote septati, 75-130(-180) x 2.5-3 µm, gradatim attenuati; peridium ca. 10-15 µm crassum, valde olivaceo-brunneum vel fere nigrum, opacum, coriaceum; stratum exterius 'textura intricata', e cellulis fuscatis, incrassatis, irregularibus compositum; stratum interius 'textura angularis', e cellulis pallidis, incrassatis, angularibus, 5-10 µm diam compositum. Asci octospori, in seriebus verticalibus dispositi, subglobosi vel ovati vel elongati, 7-13.5(-15) x (5-)6.5-7.5 µm, nonstipitati, evanescentes. Ascosporae primum dextrinoideae, stramineae, naviculares vel vulgo allantoideae, 3.8-5 (-6.5) x 1.5-2 µm, leves, poro germinationis basilari praeditae.

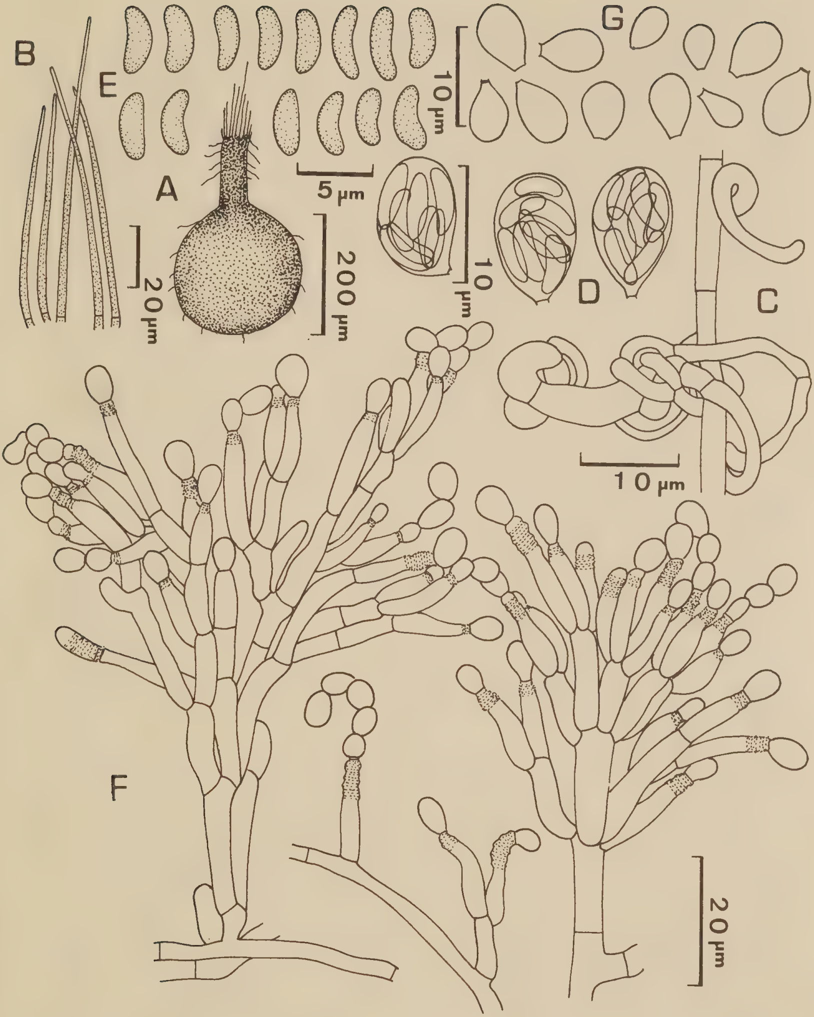
Mycelium e hyphis hyalinis vel bubalinis, ramosis, saepe anastomosantibus, pravis, levibus vel asperulis, septatis, 2-5 µm diam, saepe funiculosis compositum. Conidiophora hyalina, brevia, erecta, 8-22.5 x 3.5-7.5 µm, levia vel asperula, septata, e mycelio aerio vel basali exorientia, simplicia vel repetite et confertim ramosa ad capitulum penicillatum, saepe in pustulas aggregata. Metulae ca. 2-3 verticillatae, infra metulas saepe ramosae, 9-25 x 2.5-4.5 µm, hyalinae, leves. Annellides 2-4 verticillatae, cylindraceae, 10-35(-38) x 2.5-6.5 µm, cum zona annellata usque 7.5-20 µm longa, parum griseo-brunneae, leves, raro solitariae. Conidia hyalina, in massa alba vel dilute bubalina, ovoidea vel pyriformia, 3.5-7.5 x 2.5-5.5 µm, cum basi truncata et apice rotundo, levia et incrassata, brevi-catenata.

Holotypus: cultura NHL 2912 ex nido vespae, *Vespula flaviceps lewisii* Cameron, Kyoto, in Japonia, in ix.1981, a Y. Horie, isolata. In collectione fungorum "National Institute of Hygienic Sciences (NHL), Tokyo, Japan." Isotypus: IFM (Research Institute for Chemobiodynamics, Chiba University) 4564.

Etymology: Lat., *tardus* = slow and *-faciens* = creating, referring to the slow developing of the asci in the ascocarp.

Colonies on oatmeal agar growing restrictedly, attaining a diameter of 2.4 cm within 2 weeks at 23 C, plain, thin, vegetative mycelium submerged, white to olivaceous gray (Rayner, 1970); perithecia abundantly produced as black dots, loosely surrounded by funiculosé aerial hyphae and conidia, more or less zonate; reverse uncolored to straw (Rayner, 1970) with a grayish tint.

Perithecia semi-immersed or almost superficial, scattered or aggregated, black, flask-shaped, base globose to subglobose, 160-265 µm in diam, glabrous, very slowly matured within 5-6 weeks; neck black, cylindric, 115-185 x 35-40 µm, hairy; hairs at the neck hyaline to pale yellowish brown, straight to sinuate, unbranched, smooth-walled, remotely septate, 75-130 x 2.5-3 µm (up to 180 µm at ostiolar region), tapering gradually to a narrowly rounded end; peridium ca. 10-15 µm thick, dark olive-brown to nearly black, opaque, coriaceous; outer layer textura intricata, consisting of dark-colored, thick-walled, irregular cells; inner layer textura angularis, consisting of pale-colored, thick-walled, angular cells measuring 5-10 µm in diam. Asci 8-spored, formed in vertical rows, subglobose to ovate or elongate, 7-13.5(-15) x (5-)6.5-7.5 µm, nonstipitate, evanescent at maturity. Ascospores dextrinoid when young, straw-colored, navicular to mostly allantoid, 3.8-5(-6.5) x 1.5-2 µm, smooth-walled, with an indistinct germ pore at the base, extruded in yellowish brown cirrhi or slimy globose masses. Initials at first elongated as a thick,


B
E
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10 µm
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20 µm
200 µm
10 µm
D
C
10 µm
F
20 µm

Fig. 1. *Microascus tardifaciens.*
A. Perithecium. B. Hairs of the perithecium. C. Initial. D. Asci.
E. Ascospores. F. Conidiophores, conidiogenous cells and conidia.
G. Conidia.

club-shaped branch of hypha, then growing out to coil terminally and surrounded by a mass of narrow filaments from adjacent hyphae.

Mycelium of hyaline to buff, branched, often anastomosed, distorted, smooth-walled to slightly roughened, septate, 2-5 µm wide hyphae, often aggregated into funicles. Conidiophores hyaline, short, erect, 8-22.5 x 3.5-7.5 µm, smooth-walled or slightly roughened, septate, arising from the aerial or basal mycelium, bearing a cluster of annellides directly at the apex or repeatedly and compactly branching to form a large, dense penicillus, often crowded in pustules. Metulae borne in groups of 2-3 or more at the tips of conidiophores or frequently on intermediate rami, 9-25 x 2.5-4.5 µm, hyaline, smooth-walled. Annellides produced in verticils of 2-4, cylindric, 10-35(-38) x 2.5-6.5 µm, with annellated zone up to 7.5-20 µm long, slightly grayish brown, smooth-walled, rarely solitary on the mycelium. Conidia hyaline, white to pale buff in mass, ovoid to pyriform, 3.5-7.5 x 2.5-5.5 µm, with truncate base and rounded apex, smooth and thick-walled, forming short chains.

At 37 C, growth is nil.

Specimen examined: NHL 2912 (holotype), from nest-chamber of a ground wasp, *Vespula flaviceps lewisii* Cameron, Kyoto-city, Japan, Sept. 1981, isolated by Y. Horie in culture. IFM 4564 (isotype).

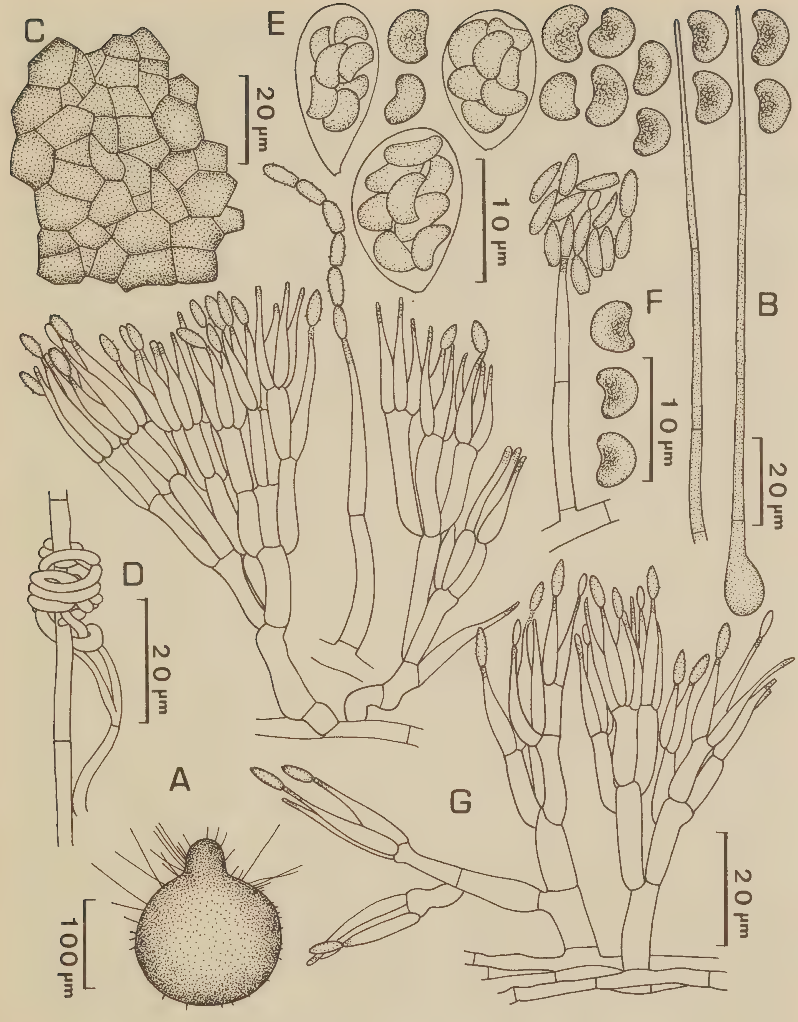
This species is morphologically closely related to *Microascus longirostris* Zukal (Barron et al., 1961b; Udagawa, 1963; Morton and Smith, 1963; von Arx, 1975) with which it was at first confused. It can be distinguished from the latter species by longer asci, narrower allantoid ascospores (3.8-5(-6.5) x 1.5-2 µm versus broadly reniform and 3-4.5 x 2-3 µm of *M. longirostris*) and larger annellides which are often borne in dense compact penicilli. *Microascus tardifaciens* resembles *M. longirostris* in its occurrence on a wasp's nest (Morton and Smith, 1963; Skou, 1973). Two other species, *M. nidicola* Massee & Salmon and *M. exsertus* Skou (=*Pithoascus exsertus* (Skou) von Arx) are also associated with bees, but they are readily separated by ascospore sizes (6-7.5 x 2-2.5 µm of *M. nidicola* and 6.7-12 x 1.3-2.5 µm of *M. exsertus*).

The anamorph of *M. tardifaciens* bears a superficial resemblance to *Scopulariopsis acremonium* (Del.) Vuill. (Morton and Smith, 1963), especially in its whitish, large and complex sporing structures, but has distinctly smaller and apically rounded conidia. It also differs from the latter in producing dense, sporodochium-like cushions of annellides which are pustular in appearance like those of *S. canadensis* Morton & G. Smith and *S. fimicola* (Cost. & Matr.) Vuill.

Petriella proteophila Horie & Udagawa, sp.nov. (Figs. 2, 9-13)
Stat. anam. *Scopulariopsis proteophila* Horie & Udagawa, anam.-sp.nov.

Coloniae in agaro farina avenae mixto celeriter crescentes, planae, tenues, e mycelio vegetativo submerso compositae, murinae vel nigrae; perithecia abunde producentia, cum hyphis aeriis albis et conidiis laxe tectae; reversum dilute murinum vel murinum.

Perithecia saepe semi-immersa vel superficialia, dispersa vel in catervis parvis aggregata, valde brunnea vel nigra, opaca, subglobosa, 140-360 µm diam, fere glabra vel laxe pilosa; pili brunnei, nonramosi, breves, usque 100-160 µm longi, septati, leves, 2-4.5 µm diam, hyphoidei; collum papilliforme, 25-35 x 35-65 µm, cum pilis brevibus, rectis, 50-100 µm longis tectum; peridium tenue, 5-7.5 µm crassum, olivaceo-brunneum vel valde olivaceo-brunneum, membranaceum, pseudo-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A
100µm
G
20µm

Fig. 2. *Petriella proteophila.*
A. Perithecium. B. Hairs of the perithecium. C. Surface view of peridium. D. Initial. E. Asci. F. Ascospores. G. Conidiophores, conidiogenous cells and conidia.

parenchymatum, 'textura angularis', e stratis duobus vel tribus compositum; stratum exterius e cellulis olivaceo-brunneis, incrassatis, angularibus, 4.5-12.5 x 3-11.5 µm compositum; stratum interius e cellulis hyalinis vel dilute flavo-brunneis, tenuibus, angularibus compositum. Asci octospori, in seriebus verticalibus dispositi, subglobosi vel ovati, (9-)10-13.5 x (6.5-)7.5-11.5 µm, saepe brevistipitati, tenues, evanescentes. Ascosporae primum guttulatae et dextrinoideae, rubro-brunneae, reniformes vel concavo-convexae, 4-5 x 2.5-3 µm, delicate reticulatae, ab utroque termino poro germinali praeditae.

Mycelium e hyphis hyalinis, ramosis, levibus, septatis, 1.5-5 µm diam, saepe funiculosis compositum. Conidiophora brevia, 10-50 x 3-5.5 µm, septata, levia, hyalina, erecta, vulgo e mycelio aerio exorientia, simplicia vel saepe polyverticillate ramosa ad capitulum penicillatum, raro in synnematibus aggregata. Metulae 3-6 verticillatae, 9-12.5 x 3-4 µm, cylindraceae. Annellides 2-8 gregariae, cylindraceae, 10-25 x 2-3 µm, cum zona annellata usque 10-12.5 µm longa, gradatim attenuatae et superne saepe sinuatae, leves, raro solitariae. Conidia hyalina, in massa alba, ovata vel ellipsoidea, 3-8 x 2-2.5 µm, cum basi truncata et apice aculeolato, subasperula, brevi-catenata.

Holotypus: cultura NHL 2913 ex solo sylvae, monte Kyozumi, Amatsukominato, Awa, Chiba, in Japonia, in 27.vii.1981, a Y. Horie, isolata. In collectione fungorum " National Institute of Hygienic Sciences (NHL), Tokyo, Japan." Isotypus: IFM 4565.

Etymology: Lat., *proteo-* = protein and *-philus* = -loving, referring to its proteophilous nature.

Colonies on oatmeal agar growing rapidly, attaining a diameter of 5.0 cm within 2 weeks at 23 C, plain, thin, vegetative mycelium submerged, mouse gray (Rayner, 1970) to black; perithecia abundantly produced, loosely covered with white prostrate aerial hyphae and conidia, gradually developed at subcentral to marginal areas; reverse pale mouse gray to mouse gray (Rayner, 1970).

Perithecia frequently semi-immersed or superficial, scattered or aggregated in small clusters, dark brown to black, opaque, subglobose, 140-360 µm in diam, almost glabrous or loosely covered with brown, unbranched, short, up to 100-160 µm long, septate, smooth-walled, 2-4.5 µm in diam, hyphal-like hairs; neck papilliform, 25-35 x 35-65 µm, covered with short, straight hairs measuring 50-100 µm long; peridium thin, 5-7.5 µm thick, olive-brown to dark olive-brown, membranaceous, pseudoparenchymatous, textura angularis, 2-3-layered; outer layer consisting of olive-brown, thick-walled, angular cells measuring 4.5-12.5 x 3-11.5 µm; inner layer of hyaline to pale yellowish brown, thin-walled, angular cells. Asci 8-spored, usually borne in vertical rows, subglobose to ovate, (9-)10-13.5 x (6.5-)7.5-11.5 µm, often with a short stipe, thin-walled, evanescent at maturity. Ascospores guttulate and dextrinoid when young, reddish brown in color, reniform or concavo-convex, 4-5 x 2.5-3 µm, marked by very low ribs that form an irregular reticulum (under SEM observation), with a single germ pore at each end, extruded as a slimy mass or as a long cirrhus. Initials at first as a coiled branch of hypha, soon becoming contorted and surrounded by adjacent hyphae.

Mycelium of hyaline, branched, smooth-walled, septate, 1.5-5 µm wide hyphae, often aggregated in funicles. Conidiophores short, 10-50 x 3-5.5 µm, septate, smooth-walled, hyaline, erect, usually arising from the aerial mycelium, simple or often branched and bearing

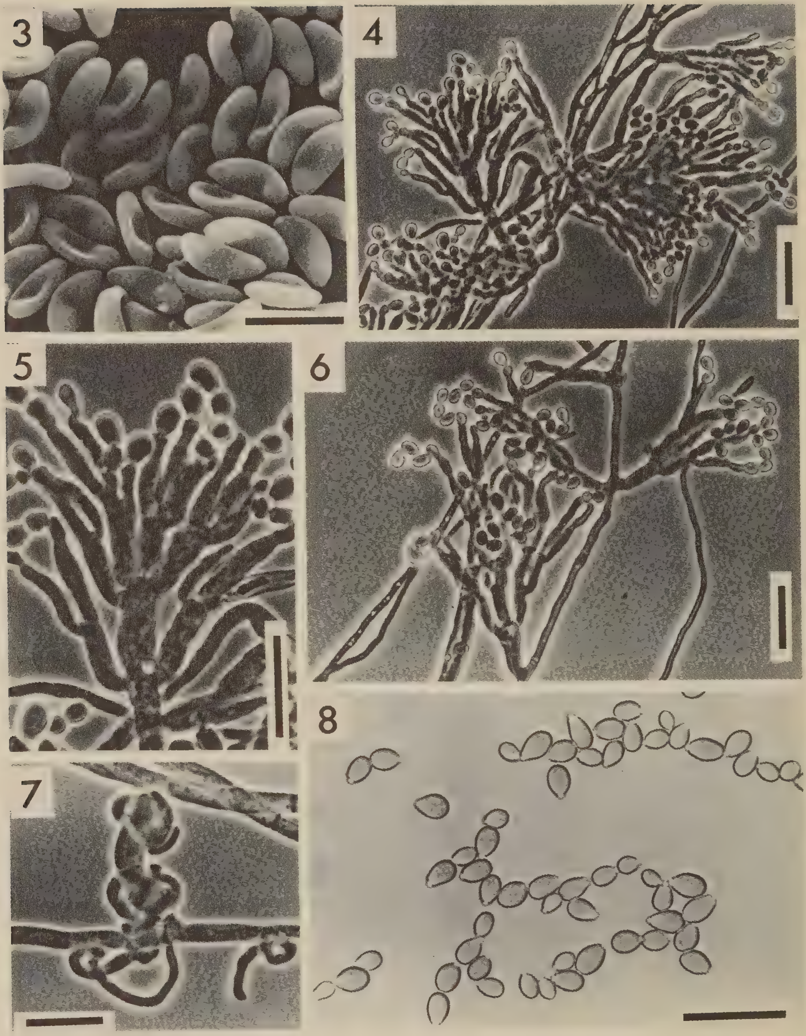
metulae, rami and ramuli, forming a dense penicillate head, occasionally united to form loose synnemata which splay at the top. Metulae 3-6 in the verticil, 9-12.5 x 3-4 µm, cylindric. Annellides produced in clusters of 2-8, cylindric, 10-25 x 2-3 µm, with annellated zone up to 10-12.5 µm long, tapering gradually and often sinuous above, smooth-walled, rarely solitary on the mycelium. Conidia hyaline, white in mass, ovate to ellipsoid, 3-8 x 2-2.5 µm, with truncate base and slightly pointed apex, finely roughened, forming short tangled chains.

At 37 C, growth in nil.

Specimen examined: NHL 2913 (holotype), from forest soil treated with urea, Mt. Kyozumi, Amatsukominato-cho, Awa-gun, Chiba-pref., Japan, July 27, 1981, isolated by Y. Horie in culture. IFM 4565 (isotype).

This species is placed in *Petriella* (Barron et al., 1961a; Malloch, 1970) because of its faster growth on common media, thin layer of the perithecial peridium and darker ascospores. It differs from the other members of the genus in producing smaller ascospores with walls often sculptured by a delicate reticulum and a *Scopulariopsis* anamorph with complex branching system (penicillate head) and mostly ellipsoid conidia rather than simple annellophores and allantoid conidia in *P. musispora* Malloch (1970). The *Scopulariopsis* anamorph is separated from *S. acremonium* and related species by its smaller conidia, besides the presence of its teleomorph.

Many members of the Microascaceae are commonly referred to as "proteolytic fungi". Morton and Smith (1963) stated that they are commonly found growing on substrates consisting largely of protein. Of particular interest here is their utilization of simple compounds of nitrogen, such as ammonia and nitrates. They are less commonly found in forest soil, for example, without any treatment, but can be easily isolated from soil with selective techniques for proteophilous fungi. In our experiments at Chiba Experimental Forest, University of Tokyo, considerably higher counts of *Kernia retardata* Udagawa & Muroi (1981) with association of *Microascus intermedius* Emmons & Dodge and *P. proteophila* were obtained in forest soil after spreading with urea (800 g per 1 m^2). On the other hand, the absence of urea had a marked depressing effect on development of members of the Microascaceae in the same forest. *Petriella proteophila* appears to be a rare species since it occurred only once in collections made almost weekly after three times spreadings over a nine-month period and this occurrence was in the fifth week of August 1981. Even though its population is so inconspicuous in the ecological aspect, extremely high dose of urea on the forest soil yielded effective colonization and isolation of this fungus.



Figs. 3-8. *Microascus tardifaciens*.
3. Ascospores (SEM micrograph). 4-6. Conidiophores, conidiogenous cells and conidia. 7. Initial. 8. Conidia.
(scale-lines: 3=5 µm, 7=10 µm, and others=20 µm.)

Figs. 9-13. *Petriella proteophila*.
9. Asci. 10-11. Ascospores (SEM micrographs). 12-13. Conidiophores, conidiogenous cells and conidia.
(scale-lines: 10-11=5 µm, 9=10 µm, and 12-13=20 µm.)

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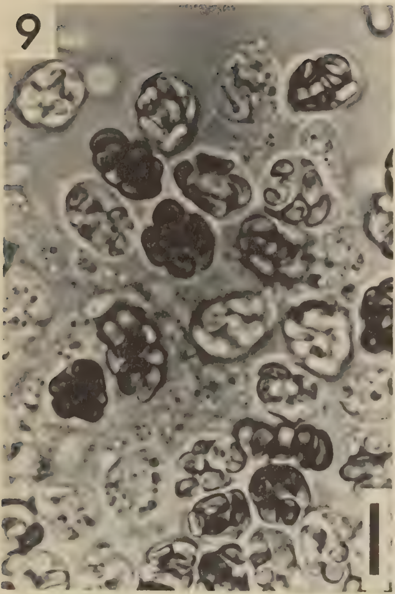

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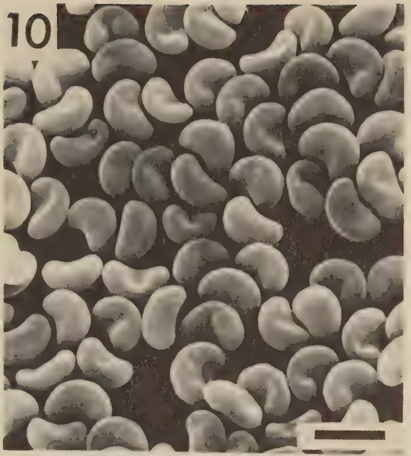

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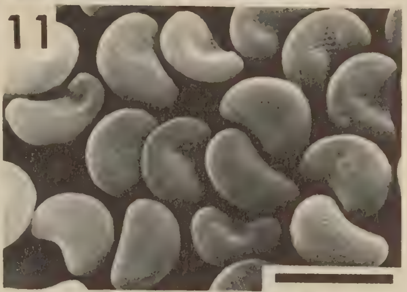

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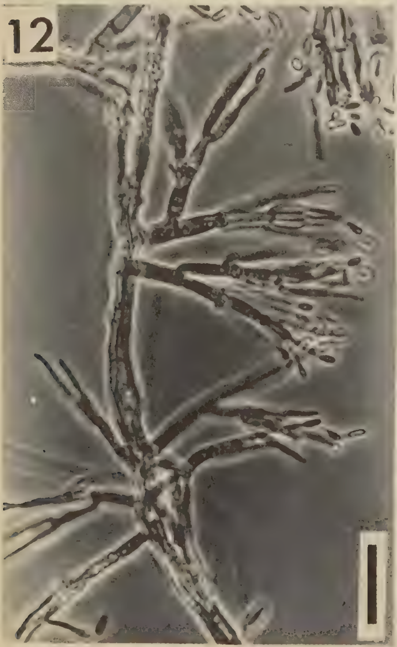

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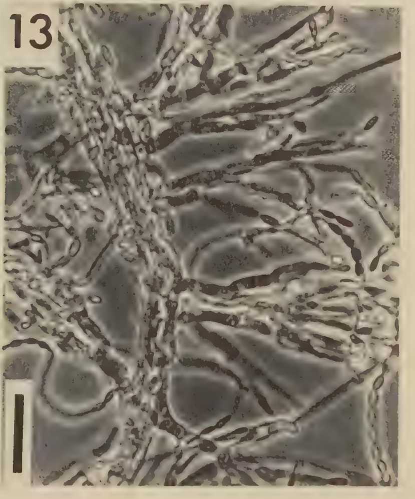

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RHINOCLADIELLA AQUASPERSA, A NEW COMBINATION FOR ACROTHECA AQUASPERSA

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ABSTRACT

The new combination *Rhinocladiella aquaspersa* (Borelli) Schell, McGinnis et Borelli is proposed and a neotype designated for the dematiaceous hyphomycete originally described as *Acrotheca aquaspersa* Borelli.

INTRODUCTION

In 1972, Borelli (2) described the new taxon *Acrotheca aquaspersa* as a previously unknown etiologic agent of human chromoblastomycosis. This taxon was characterized in part by the formation of erect, dematiaceous, sympodial conidiophores bearing 1-celled conidia in an acropleurogenous arrangement. De Hoog (7) studied Borelli's isolate, as well as the type culture of *A. cerophila* Tubaki 1958, concluding that these two taxa were conspecific. The new combination *Ramichloridium cerophilum* (Tubaki) de Hoog 1977 was proposed with *A. aquaspersa* being treated as a later synonym of *Ra. cerophilum*. While studying the genus *Fonsecaea* Negroni 1936, McGinnis and Schell (9) suggested that these taxa were not conspecific and that *A. aquaspersa* could be adequately accommodated in the genus *Rhinocladiella* Nannfeldt 1934.

METHODS AND MATERIALS

Living cultures were studied on potato dextrose agar (PDA) after incubation for 2-5 weeks at 25°C in the dark. Growth rates were determined after 14 days on PDA at 25°C in the dark. Average size measurements are expressed as arithmetic means. Colors are based on Ridgway (12).

Herbarium specimens examined. *Rhinocladiella atrovirens* labelled paratypus, No. 16039, Mus. Botan. Upsaliense, isolated from "white water" (dried colony) by E. Melin, Värmland: Glava par., Hilbringsberg, Haga trasliperi; *R. atrovirens* labelled paratypus, No. 211:3II, Mus. Botan. Upsaliense, isolated from "white water" (slide) by E. Melin, Angermanland: Sabra parish, Ulfviks Tramassefabrik; *R. atrovirens* labeled paratypus, No. 59:36, Mus. Botan. Upsaliense, isolated from pine (slide) by E. Melin, Uppland: Alvkarleo. The holotype for *Acrotheca cerophila* was unavailable for study.

Living cultures examined. NCMH 76 (= ATCC 24410 = CBS 313.73 = CDC B-1918 = FMC 241), culture derived from the original isolate of *Acrotheca aquaspersa*, isolated from human case of chromoblastomycosis, A. Gonzalez-Ochoa, Mexico; NCMH 732 (= CBS 103.59), culture derived from the type of *A. cerophila*, isolated from leaf of *Sasa sp.*, K. Tubaki, Japan; NCMH 799 (= CBS 317.33), living culture reportedly derived from the paratypus of *R. atrovirens*, isolated from pine wood, E. Melin, Uppland, Sweden; NCMH 835 (= FMC 242), received as *A. aquaspersa* from human chromoblastomycosis, Ferreira Lopes, Brasil; NCMH 1035 (= ATCC 13211 = CBS 156.59 = IMI 100716 = Miller 2805), culture derived from the type of *Chloridium apiculatum*, isolated from forest soil, J. H. Miller *et al.*, Georgia, U.S.A.; NCMH 1057 (= CBS 365.36), authenticated isolate of *C. musae* isolated from leaves of *Musa sapientium*, G. Stahel, Paramaribo, Surinam; NCMH 1260 (= FMC 295), isolated from human case of chromoblastomycosis, F. Montero Gei, San José, Costa Rica.

TAXONOMIC PART

Rhinocladiella aquaspersa (Borelli) Schell, McGinnis et Borelli, comb. nov.

≡ *Acrotheca aquaspersa* Borelli, Acta Cient. Venez. 23:195, 1972 (basionym).

= *Ramichloridium cerophilum* sensu de Hoog, Stud. Mycol. 15:74, 1977 pro parte, non *Acrotheca cerophila* Tubaki, J. Hattori Bot. Lab. 20:143, 1958.

NCMH 76: After 14 days, colony 13 mm in diameter, velvety, elevated; olivaceous black with reverse olivaceous black; margin sharp, regular. Hyphae smooth, mid-to pale brown. Conidiophores usually darker than vegetative hyphae, well developed, 21.2-82 x 1.3-3.5µm (42.4 x 2.4µm), typically 2-4 septate, macronematous, unbranched, erect, straight, often tapering slightly, conidiogenous zone elongated and scarred, scars partially to prominently raised with pigmentation not differing from the remainder of the fertile region. Conidia developing from sympodial conidiophores fusiform, elliptical, or obovate, 0 (rarely 1)-septate, smooth, mid-brown, 4-9 x 1.3-2.6µm (5.4 x 1.9µm), with dark basal scar. Occasional annellides, typical of *Exophiala* Carmichael 1966, may be present, as well as phialides similar to those produced by *Wangiella* McGinnis 1977.

NCMH 76 is identical to the original description for this species. NCMH 1399, a dried colony derived from NCMH 76, has been deposited in The National Fungus

Collection (BPI), Beltsville, Maryland as the neotype. Because a living culture can not serve as the type and no specimens were prepared at the time of publication, it follows that a specimen prepared from a subsequent subculture of the original isolate should be considered a neotype.

DISCUSSION

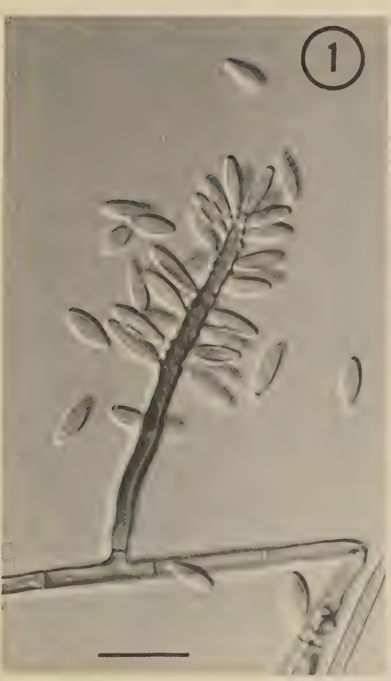
In 1860, Fuckel (5) established the genus *Acrotheca* based upon *A. gei* with the following description: "Peritheciis numerosis, acuminatis, nitidoatris, in maculis orbicularibus sordidis margine purpureis. Syn. *Depazea geicola* Fr. (?). Ad Gei urbani folia radicalia viva, non frequens. Vere." In a later study (6) published in 1870, Fuckel considered *A. gei* to be a later synonym of *Depazea geicola* Fr. Sutton (14) believes that the genus *Depazea* should be treated as a later synonym of the Coelomycete genus *Asteroma* DC. 1815. Hughes (8) examined an authentic specimen of *Acrotheca gei* and concluded that the genus *Acrotheca* should be treated as a later synonym of *Ramularia* Unger 1833. The specimen Hughes examined contained immersed stromata, each of which produced a cluster of conidiophores bearing acropetal chains of 0- or 1-septate conidia. The genus *Ramularia* is unacceptable for *A. aquaspersa* and *A. cerophila* because it is characterized by having hyaline or dematiaceous 0- to several-septate, catenulate blastoconidia originating from sympodial, cicatrized conidiophores.

Matsushima (10) transferred *A. cerophila* to the genus *Cladosporium* Link 1815 as *C. cerophilum*. De Hoog (7)

Fig. 1. *Rhinocladiella aquaspersa* (NCMH 76), sympodial conidiogenous cells and 1-celled conidia, 2 weeks, PDA. Bar is 10µm.

Fig. 2. *Ramichloridium cerophilum* (NCMH 732), sympodial conidiogenous cells and 1-celled conidia in short acropetal chains, 4 weeks, PDA. Bar is 10µm.

Fig. 3a, 3b. *Rhinocladiella atrovirens* Mus. Botan. Upsaliense No. 16039, sympodial conidiogenous cells and 1-celled conidia. Bar is 10µm.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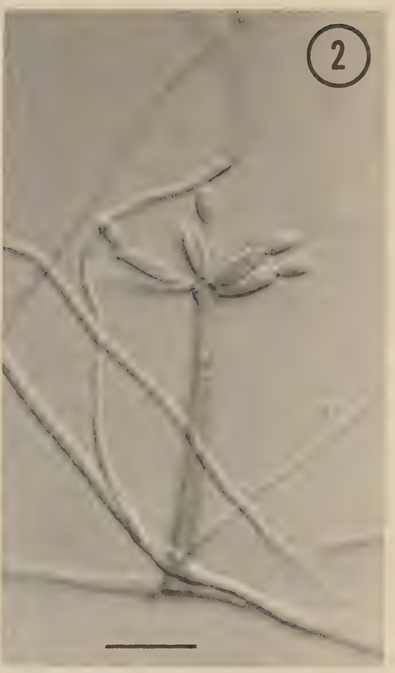
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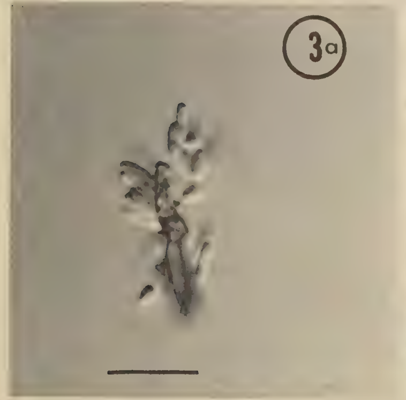
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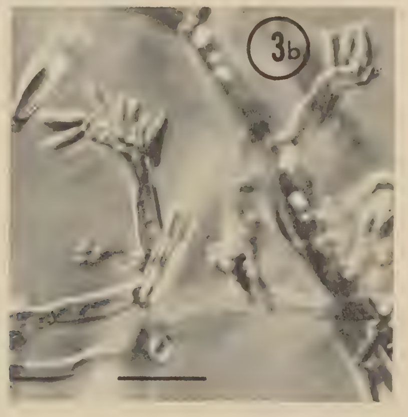
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disagreed with Matsushima's treatment of *A. cerophila*, classifying *A. cerophila* in the genus *Ramichloridium* which was proposed in 1937 by Stahel to accommodate *Ra. musae*. The genus was invalidly published because a Latin diagnosis was not provided. In 1967, Ellis (4) described *Ra. musae* as a new species of *Periconiella* Saccardo 1885, and placed *Ramichloridium* into synonymy with *Periconiella*. De Hoog (7) did not accept this treatment. He provided the necessary Latin description for *Ramichloridium*, and designated *Chloridium apiculatum* Miller, Giddens et Foster as the type species for the genus *Ramichloridium* rather than *Ra. musae* as originally proposed by Stahel. De Hoog felt that this was necessary because *C. apiculatum* was more central to his concept of *Ramichloridium*. In addition, de Hoog considered *A. aquaspersa* to be a later synonym of *Ra. cerophilum*. He stated that "*Ramichloridium* is not sharply delimited from *Rhinocladiella* ..." and "Species of *Ramichloridium*, however, are not pathogenic to man and only rarely pleomorphic, the sympodial state remaining predominant." Placement of *A. aquaspersa* in the genus *Ramichloridium* on these bases is in conflict with the fact that this polymorphic species is an etiologic agent of human chromoblastomycosis.

McGinnis and Schell (9) suggested that de Hoog's concept of *Ramichloridium* was too broad because it included species that could be adequately accommodated in either the genera *Rhinocladiella*, *Periconiella*, or *Veronaea* Ciferri et Montemartini 1957. They also rejected de Hoog's treatment of *Fonsecaea* as a later synonym of *Rhinocladiella* because the development of the conidial apparatus in the genus *Fonsecaea* is distinctively different from *Rhinocladiella*.

A major difficulty concerning the taxonomy of polymorphic fungi is determining which name should be applied to the fungus. Rather than basing the binomial on a combination of synanamorphs, we believe that the name should be based upon the single anamorph that is most stable and distinctive (9). In the case of *R. aquaspersa*, the erect sympodial conidiogenous cells bearing 1-celled conidia in an acropleurogenous manner is the most distinctive and stable anamorph formed. Isolates NCMH 799 and NCMH 76 contain an accompanying annellide anamorph like that seen in *Exophiala*. NCMH 76 also contains an accompanying phialide anamorph compatible with *Wangiella*.

Study of the appropriate herbarium specimens and living cultures has shown that *R. aquaspersa* and *Ra. cerophilum* are not conspecific. *Rhinocladiella aquaspersa* only rarely forms acropetal chains of conidia, and the well developed sympodial conidiophores have an extended conidiogenous zone (Fig. 1). Only infrequently does *Ra. cerophilum* produce such well developed sympodial conidiophores. *Ramichloridium cerophilum* typically forms conidiophores that exhibit limited sympodial development at the apex and bear ramoconidia that give rise to fragile, branched, acropetal chains of 2 or 3 conidia which lack prominent hila (Fig. 2). This anamorph in *Ra. cerophilum* is the predominant and most distinctive form, and is reminiscent of the genus *Hormoconis* (Lindau) Arx et de Vries 1973 (1, 3). *Ramichloridium cerophilum* (NCMH 732) has an accompanying *Rhinocladiella* anamorph. Additional isolates of *Ra. cerophilum* must be studied before its final disposition can be adequately resolved.

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FOLIICOLOUS ASCOMYCETES 5: THE CAPNODIACEOUS CLYPEATE GENUS TREUBIOMYCES

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Summary

The genus Treubiomyces Höhnel is revised to include species with a capnodiaceous centrum, hyaline muriform ascospores, and an ascocarp appendaged with a clypeus. Four species, T. funtumiae, T. pacificus, T. pulcherrimus, and T. roseosporus are recognized.

Foliicolous capnodiaceous fungi with a clypeated ascocarp have been generally grouped under a name first given family status by Hansford (1946a) and ordinal status by Batista and Ciferri (1962). Barr (1976) validated the family name, Chaetothyriaceae, with the Latin description required by the International Code of Botanical Nomenclature. Barr (1976) redefined the family as having a centrum containing elements termed periphysoids, although she recently (1982) disavowed the periphysoids as a significant taxonomic character. These structures have a postascus origin from the inner surface of the ascocarp wall and protrude into the ascocarp locule. This feature was combined with an appendage of the outer ascocarp wall, the clypeus, to give the family its basic parameters. Eriksson (1981) defined this type of locular tissue construction as a hamathecium with periphysoids (type 5). The periphysoids are a basic feature of the Capnodium-centrum (Reynolds, 1978). Thus the taxa usually placed in the Chaetothyriaceae are said here to be capnodiaceous and clypeate.

The clypeated capnodiaceous or chaetothyriaceous ascocarp has been noted by Theissen (1913) Theissen and Sydow (1917), and Woronochin (1925). Three detailed studies of the structure of this ascocarp have been done. Bitancourt (1936) gave details of Chaetothyrium guaraniticum, the type species of the genus. He established that the clypeus is a distinct structure attached to an ascocarp at the upper portion of the outer fruit body wall. Batista and Ciferri (1957) offered observations on this development type, but without indicating the specific source of their data. Their model, "...summarized the average cycle for the entire order.", i.e. their taxon the Chaetothyriales. Pohlad (1980) undertook a developmental study of the ascocarps of a chaetothyriaceous species, Treubiomyces pulcherrimus. Pohlad reported that ascocarp formation was initiated from meristematic areas in the mycelium. The hyphae of localized circular areas then developed into a clypeus initial. The ascocarp proper formed under the clypeus initial and both structures enlarged with age and maturation of the centrum.

I regard the clypeus as an appendage of the developing and mature ascocarp, irrespective of the sequential appearance of the clypeus initial before the ascocarp initial. The clypeated ascocarp clearly undergoes a developmental progression of its own. The clypeus expands during the development of the ascocarp and as a result continues to cover the increasing fruit body surface. The expansion of the clypeus in tandum with the maturation of the ascocarp is the apparent cause of an infraclypeate space between the place of the attachment of the clypeus to the ascocarp wall and the substrate beneath the fruit body. This region is usually filled with hyphal strands which individually continue from the ascocarp into the general mycelium, i.e. not forming plectenchyma. Without the clypeus the ascocarp would resemble those of Limacinula species (Reynolds, 1971). The flattened dimidiate fruit body, produced by hemisphaeriaceous fungi such as the Micropeltaceae (Batista, 1959), or the Microthyriaceae (Stevens and Ryan, 1939) might be comparatively viewed as a shield directly covering a hymenium.

Thus the clypeated ascocarp can be recognized in a thin section cut along a longitudinal axis by two criteria: (1) a plectenchymatous clypeus attached to the upper portion of the outer ascocarp wall and (2) an infraclypeate space filled with hyphal strands continuing individually from the ascocarp wall into the substrate.

Setae are sometimes to be found on a clypeus. Höhnel (1909) utilized basally lobed setae on the clypeus as a distinguishing character of Treubiomyces pulcherrimus. He noted the setae arose from wart-like mounds on the clypeus and were similar to ones to be found on mycelium surrounding the ascocarp. Pohlad (1980) distinguished two setal types associated with T. pulcherrimus. He described the setae originating in the clypeus as having bulbous bases and thick, dark brown to black walls. Batista and Ciferri (1962) utilized the presence or absence of setae on the clypeus as a character to separate taxa at the generic level. As a result, two parallel series of genera were distinguished by this criterion. This approach was followed by Luttrell (1973), Arx and Müller (1975), and Hughes (1976). Pohlad (1980) concluded that use of setae to distinguish chaetothyriaceous genera is questionable. Petrak (1929) also regarded the presence or absence of setae on the clypeus as a varible character. Boedijn (1931) in a discussion of Indonesian Chaetothyrium species and Fraser (1935) in a treatis on capnodiaceous fungi in Australia endorsed Petrak's conclusion. Their view is not fully accepted in the present treatment because the variability they perceived in a character such as ascospore septation is considered stable; accordingly they regarded Treubiomyces as congeneric with Chaetothyrium.

The developmental studies cited above and the examination of specimens recorded in the literature as well as many recent field collections have led me to regard the presence or absence of setae on the clypeus as an unstable taxonomic character. I am convinced that chaetothyriaceous species may show considerable varability in the production of setae on the clypeus and that not all ascocarps will illustrate this character consistently. Therefore, I regard the potential presence of setae on the clypeus as a widespread character.

The asci of the species in this genus are regarded as bitunicate. The outer wall or ectotunica, of the ascus stained blue with KOH-IKI treatment (Kohn and Korf, 1975) in those tested. The inner wall or endotunica of this ascus may have an apical modification. Pohlad (1980) noted an apical ring in the tip of the mature ascus of Treubiomyces pulcherrimus. Reynolds (1981) noted that this ascus tip modification also occurs in the capnodiaceous genus Trichomerium.

Treubiomyces Höhnel. Höhnel, 1909:1181-1182.

=Paropsis Spegazzini. Spegazzini, 1918:284.
=Ainsworthia Batista & Ciferri. Batista and Ciferri, 1962:4-5.
=Mycostevensonia Batista & Ciferri. Batista and Ciferri, 1962:60-61.

Teliomorph: Ascospores hyaline to roseate, muriform; ascus wall with bitunicate structure, endotunica apically modified with a ring or not; hymenium basal, surrounded by fruit body wall which is internally appendagaed with periphysoids and externally appendaged at maturity with a clypeus; setae present or on clypeus or not; ascocarp cell walls brown pigmented, formed around a single centrum. Anamorph: incertis.

Type species: Treubiomyces pulcherrimus

Treubiomyces is distinguished from other clyeated capnodiaceous genera by the hyaline muriform ascospores which may have a pinkish tinge. Perhaps for the reason of the pinkish color, in addition to the light golden color of the ascocarp, Höhnel assigned the genus to the Nectriaceae (1909). As Höhnel noted, the taxon was named for Dr. Melchior Treub, the director of the Bogor Botanical Garden at the time of Höhnel's visit there seventy-six years ago.

Distribution: The distribution of this genus appears to be subtropical or in upland areas of the tropics. Brasil (Rio Grande Do Sul), Indonesia (Java), Mexico, Taiwan, Uganda, USA (Florida).

Excluded genera

Deslandesia Batista in Batista & Ciferri. Batista and Ciferri, 1962:40.

This genus is not validly published because Batista and Ciferri (1962) failed to indicate a type species.

Key To Species

A Ascospores with less than 10 transsepta..................B
B Ascospores less than 30µm in length
Treubiomyces pacificus
B' Ascospores more than 30µm in length
Treubiomyces pulcherrimus
A' Ascospores with 10 or more transsepta....................C
C Ascospores 90-120µm in length
Treubiomyces funtumiae
C' Ascospores 50-100µm in length
Treubiomyces roseosporus

1. _Treubiomyces funtumiae_ (Hansford) nov. comb.

Basionym=_Actinopeltis funtumiae_ Hansford. Hansford, 1941:17. Pro parte, Teleomorphosis only.
≡_Phaeosaccardinula funtumiae_ (Hansford) Hansford. Hansford, 1946a:17.
≡_Mycostevensonia funtumiae_ (Hansford) Batista & Ciferri. Batista and Ciferri, 1962:60.
=_Mycostevensonia ingae_ Batista and Peres in Batista Peres & Bezerra. Batista, Peres and Bezerra, 1962:113-115.

Teleomorph: Ascospores hyaline, muriform, allantoid, with 20-30 transsepta and one sometimes two longisepta in many cells, 90-120 x 12-13µm; ascus at maturity 130µm in length; hymenium basal; periphysoids lining upper area of inner ascocarp wall; clypeus tissue textura globulosa with raised cells especially in the upper portions, diameter up to 300 µm; ascocarp 100-150µm high, wall cells containing light brown pigment, depressed globose, ostiolate. Anamorph: incertis.

Holotypus: collected by C. G. Hansford #1419, Uganda, Butambula.

Lectotypus: collected by C. G. Hansford, #2932. December 1940. Uganda, Entebbe Road.

Illustrations: Hansford, 1946a:156 (=Batista and Ciferri, 1962:63); Batista, Peres and Bezera, 1962:114,115.

This species was first described in the Trichothyriaceae (Hansford, 1941). Without explaination, Hansford (1946) emended the description with the transfer to *Phaeosaccardinula*. I was unable to locate the holotype. Specimens cited in the 1946 redescription were examined and one of these is cited as a lectotype.

2. *Treubiomyces pacificus* Reynolds ex Batista & Nascimeno nov. sp.

Latin diagnosis as *Deslandesia pacifica* Batista & Nascimento in Batista & Ciferri, 1962:46-47. Pro parte, Teleomorphosis only. [Not validly published since generic name not validly published.]

Teleomorph: With characteristics of the genus. Ascospores hyaline muriform, clavate to slightly lunate, with (6-) 7 transsepta and an interrupted longiseptum, 16-25 x 8-9µm; ascus at maturity clavate, 35-55µm in length; hymenium basal; clypeus tissue textura intricata with raised cells, diameter up to 220µm, ascocarp subglobose, 145-195µm in diameter x 93-110µm in height; wall 14-17µm thick, cells containing light brown pigment. Anamorph: incertis.

Holotypus: collected in Mexico, Vera Cruz, Coatepec, "La Laguna". 17 May 1947. Located in BPI.

Illustrations: Batista and Ciferri, 1962:48.
This species is distinguished by the ascospore shape and size from the other three species in this genus.

The spores are illustrated in Batista and Ciferri (1962) as having 7 or 8 transsepta; the description by Batista and Nascimento mentions 4-6. Batista and Nascimento imply that the person who made the first determination (as *Capnodium* sp.), M. Zenteno, was the collector.

The name of this species is treated as a new one and credited to A. C. Batista and M. L. Nascimento. The indirect reference is to a description supplied by these authors which is invalidly published. Although the species name meets the valid publication requirements of the International Code of Botanical Nomenclature, the genus, described in the same publication, does not (Article 37). The species is published as a new taxon because of the original generic invalidity and the recognition of the species in a different genus resulting in a different combination than that invalidly published. Four species and four varities of the invalid genus, *Deslandesia* are misidentifications. Two of the taxa placed in the genus are synonyms of *Treubiomyces roseosporus*. *D. pacifica* is the only species recognized from the original Batista and Ciferri group.

3. *Treubiomyces pulcherrimus* Höhnel. Höhnel, 1909:1181-1182. Emend. Pohlad and Reynolds, 1974:521. Pro parte, Teleomorphosis only.

=*Ainsworthia xanthoxylii* Batista in Batista & Ciferri. Batista and Ciferri 1962:7-8. Pro parte, Teleomorphosis only.

Teleomorph: Ascospores hyaline to subhyaline, muriform, oblong with 7-9 transsepta and an interrupted longiseptum, 32-39 x 77-10µm; ascus 8-spored, clavate, 60-70µm in length; hymenium basal; periphysoids lining upper area of inner ascocarp wall; clypeus tissue textura intricata, diameter to 600µm; ascocarp globose to depressed globose, cell walls 20-25µm in diameter, containing light brown pigment, 120-170 x 100-170µm; ostiolate. Anamorph: incertis.

Holotypus: collected by Frantz von Höhnel. Indonesia, Java, Tjibodas, 1908. located in Herbarium F.

Illustrations: Höhnel, 1909:1181. Batista and Ciferri, 1962:7. Pohlad and Reynolds, 1974:522. Pohlad, 1980.

Pohlad and Reynolds (1974) failed to note periphysoids in the ascocarp cavity of this species. Pohlad (1980) clearly illustrates them in Figures 18-21. The illustration by Batista and and Costa (Batista and Ciferri, 1962) is somewhat atypical. The shield does not normally contain inflated cells near the attachment of the clypeus to the ascocarp as illustrated in Figure 3; additionally the ascospore cells are shown as somewhat inflated. Batista and Ciferri considered the ascus to be "one tunicate".

Batista and Ciferri cite five specimens in addition to the type. Only URM2799 could be determined as *T. pulcherrimus*. URM9226 from Puerto Rico and URM9246 from Cuba are redetermined as *Limacinula samoensis*. Two of the collections, URM9953 and URM9950, are George Martin collections from Green Cove Springs, Florida, USA. A third Martin collection is miscredited with a New Jersey locality. This place name was apparently taken from the information associated with the address of J. B. Ellis and B. M. Everhart in connection with the issuance of the North American Fungi exsiccati (Stevenson, 1971). G. Martin was a contributer to this series with specimens from Green Cove Springs, Florida during 1881-1883.

4. *Treubiomyces roseosporus* (Höhnel) nov. comb.

Basionym=*Limacinula roseospora* Höhnel. Hohnel, 1910:913. Pro parte, Teleomorphosis only.
≡*Paropsis roseospora* (Höhnel) Spegazzini. Spegazzini, 1918:184.
≡*Chaetothyrium roseosporum* (Höhnel) Petrak in Fraser. Fraser, 1935:283.

≡*Deslandesia roseospora* (Höhnel) Batista & Ciferri. Batista and Ciferri, 1962:49-50. [Not validly published since genus not validly published.]

=*Phaeosaccardinula longispora* Yamamoto. Yamamomo 1956:169. Pro parte, Teleomorphosis only.

≡*Deslandesia longispora* (Yamamoto) Batista & Ciferri Batista and Ciferri, 1962:45-46. [Not validly published since genus not validly published.]

Teleomorph: Ascospores hyaline to appearing very light pink, oblong, clyindric, muriform, with 13-22 traverse septa and an interupted longiseptum, 50-98 x 7-13µm; prespore ascus clavate, 70-100µm, enlarged at maturity to accomodate eight ascospores; hymenium basal; periphysoids lining lateral to apical area of inner ascocarp wall; clypeus comprised of textura globolusa tissue, diameter up to 300 µm; ascocarp globose, cell wall containing light brown pigment 200 x 150µm; ostiolate. Anamorph: incertis.

Holotypus: collected by P. Theyssen. Brazil, Rio Grande do Sul, Sao Leopoldo. 1908. located in FH.

Illustrations: Höhnel, 1910:914 (=Batista and Ciferri, 1962:52). Fraser, 1935:284.

Spegazzini (1918) based *Paropsis* on *Limacinula roseospora* Höhnel. The genus was placed in the Lasiobotryaceae with a reference to Saccardo's reprint (1897) of Höhnel's description, rather than the original description (Höhnel, 1910). Thus, I suspect that Spegazzini did not utilize the type or other authenticated material in his creation of the new genus. Saccardo and Trotter (1926) reprinted the Spegazzini placement in Lasiobotryaceae and cited *Paropsis* Speg. n. gen. Gould (1962) listed a family, Paropsidiaceae; it was also listed by Cooke and Hawksworth (1970) with no additional reference. Eriksson (1981) pointed out that the name is a nomen nudum and cited the family as Paropsidaceae, nom. dub.

Imperfectly known species

Treubiomyces japonicus Hara. Hara, 1931:22.

This species was described from in Japan. I have been unable to locate the holotype. It was not present among specimens examined at Herbarium TNS.

Excluded Species

1. *Deslandesia honoluluensis* Batista & Vital in Batista & Ciferri. Batista and Ciferri, 1962:42-43.

This species is apparently based on fruit bodies from more than one species in more than one collection. Two

California specimens with *Limacinula anomala* were utilized; one Hawai'ian specimen with *Chaetothyrium mangiferum* was also cited.

2. *Limacinula malloti* Rehm. Rehm, 1962:156.
   ≡*Phaeosaccardinula malloti* (Rehm) Theissen in Theissen Sydow. Theissen and Sydow 1917:481.
   ≡*Deslandesia paulensis* (Rehm) Batista & Ciferri var. *malloti* Batista & Ciferri. Batista and Ciferri, 1962:48-49.[Not validly published since generic name not validly published.]

Batista and Ciferri (1962) listed *Limacinula malloti* Rehm as one of two synonyms of their *Deslandesia* variety. *L. malloti* is a synonym of *Limacinula samoensis* (Reynolds, 1971). Batista and Ciferri also listed *Chaetothyrium hawaiiense* Mendoza as a synonym of this variety; *C. hawaiiense* has apparent similarities with *Trichomerium grandisporum*, because of the ascospores and the setae.

3. *Phaeosaccardinula jasminii* Hansford. Hansford, 1965:191
   ≡*Mycostevensonia jasminii* (Hansford) Batista and Ciferri. Batista and Ciferri, 1962:62.

The muriform ascospores of this species are not hyaline.

4. *Phaeosaccardinula morindae* Mendoza in Stephens. Stephens, 1925:59.
   ≡*Ainsworthia morindae* (Mendoza in Stephens) Batista in Batista & Ciferri. Batista and Ciferri, 1962:5.

This species is redetermined as *Limacinula theae*. Batista incorrectly cited F. L. Stevens as the author of the taxon.

5. *Phaeosaccardinula seaveriana* Toro. Toro, 1925:145.
   ≡*Ainsworthia seaveriana* (Toro) Batista and Ciferri. Batista and Ciferri, 1962:6.

This species is redetermined as *Limacinula samoensis*. A *Trichomerium* is also present in the type collection.

6. *Phragmocapnias smilicina* Mendoza in Stephens. Stephens, 1925:58-59.
   ≡*Ainsworthia smilacina* (Mendoza) Batista & Vital in Batista & Ciferri. Batista and Ciferri, 1962:6-7.

This species was cited from the collection ILL6667 which was designated by Mendoza (Stephens, 1925) as the type for *Phragmocapnias smilicina*. Batista and Ciferri (1962) state, "Obs: This specimen was designated as the type of *Phragmocapnias smilicina* Mendoza,which we have not found." I examined ILL6667 and BISH3836. *P. smilicina* is a species in the genus *Limacinula*; *A. smilacina* was not found in the two type specimens; from Batista and Vital's description, I judge that this name is a synonym of *Limacinula anomala*.

7. *Teichosporella negeriana* Saccardo & Sydow in Sydow & Sydow. Sydow and Sydow, 1904:163.
   ≡*Ainsworthia negeriana* (Saccardo & Sydow in Sydow & Sydow) Batista & Ciferri. Batista and Ciferri, 1962:5-6.

This species belongs in the genus *Limacinula*.

8. *Treubiomyces celastri* Doidge. Doidge, 1927:239.
   ≡*Shanoriella celastri* (Doidge) Batista & Ciferri. Batista and Ciferri, 1962:101-102.

This is a microthyriaceous species.

Specimens examined

The specimens examined for this revision of *Treubiomyces* are listed by the collectors. The data given for each collection are the original accompanying the collection. Associated plant information and locality names are treated as original collection data and updating is not attempted. The original determinations for the fungus related to this study is cited. An asterisk indicates type material.

ANONYMOUS. Mexico, Vera Cruz, Coatepec, "la Laguna": May 1947: on citrus: BPI (ex Herb. Critogamico, Oficina de estudios especiales S.A.G., San Jacinto, D. F. Mexico); LAM207239: *Meliola penzigi*.

BAKER, C. F. #878. Philippines, Laguna, Los Baños: 25 March 1913: on *Mallotus philippensis*:S*(ex Herb. Sydow, ex Herb. Rehm, ex Rehm: Ascomycetes 2075); LAM200822. S(ex Rehm:Ascomycetes 2075); LAM200817. S(ex Herb. Sydow, ex Rehm:Ascomycetes 2075); Lam200819. S(ex Herb. Sydow); LAM200820. BPI(ex Rehm: Ascomycetes 2075); LAM200576. BPI(ex Rehm:Ascomycetes 2075); LAM200747. UC528216; LAM200887. URM4809*(ex Rehm: Ascomycetes 2075); LAM201243. LAM206502(ex Rehm:Ascomycetes 2075): *Limacinula malloti*.

CHARLES V. K. and A. BALLON. Cuba, Rincon: 3 July 1927: on *Lacuma mammosa*: URM9246; LAM200559: *Ainsworthia xanthoxylii*.

DOIDGE, E. M. South Africa, Tul, Zoutpansberg, Woodbush: 10 September 1923: on *Gymnosporia*: PRE17769*; LAM200739: *Treubiomyces celastri*.

FRASER, L. Australia, New South Wales, Pittwater: October 1934: on *Guioa semiglauca*: IMI26103(ex Herb. V. H. Petrak); LAM205458: *Phaeosaccardinula roseospora*./ Australia, New South Wales, Grafton: January 1935: on *Endiandra sieberi*: DAR12601; LAM207240: *Chaeothyrium roseosporum*./ Australia, New South Wales, Blackheath: 16 March 1935: on *Doryphoea sassafras*: DAR12682; LAM207241: *Chaetothyrium roseosporum*.

GARNIER, R. Brazil, Amazonas, Manaus, Cachera de Taruma: 24 May 1961: On *Inga fagifolia*: IMI15770*; LAM201496: *Mycostevensonia ingae*

HANSFORD, C. G. #2932. Uganda, Entebbe Road: March 1944: on *Hugonia platysepala*: IMI5122*; LAM201537: *Actinopeltis funtumiae*./ #3298. Uganda, Entebbe Road:

November 1943: on *Jaundea monticola*: IMI4846; LAM201540: *Phaeosaccardinula funtumiae*./ #3370. Uganda, Entebbe Road: March 1944: on *Hugonia platysepata*: IMI4239; LAM201541: *Phaeosaccardinula funtumiae*./ Uganda, Kuagive, Mukono, Phoferos Bosque: February 1941: IMI68384; LAM200970: *Actinopeltis funtumiae*./ #2954. Uganda, Entebbe Road: December 1940: on *Jasminium dichotomum*: IMI5959*; LAM201025: *Phaeosaccardinula jasmini*./ #3406. Uganda, Entebbe Road: March 1944: on *Jasminium dichotomum*: IMI48496; LAM201542: *Phaeosaccardinula jasmini*./ #3199. Uganda, Entebbe Road: March 1943; on *Jasminium dichotomum*: IMI4518; LAM201538: *Phaeosaccardinula jasmini*./ #3468. Uganda, Entebbe Road: May 1944: on *Jasminium dichotomum*: IMI4978; LAM201543: *Phaeosaccardinula dichotomum*./ #3234. Uganda, Entebbe Road: November 1943: on *Jasminium dichotomum*.

HÖHNEL, Frantz von. Indonesia, Java, Tjibodas: FH*(ex Herb. Hohnel): *Treubiomyces pulcherrimus*.

MARTIN, George. USA, Florida, Green Cove Springs: on *Quercus laurifolia*: URM9950; LAM201564: *Ainsworthia xanthoxylii*./ USA, Florida, Green Cove Springs: on *Andromeda ferruginea*: URM9953; LAM201565: *Ainsworthia xanthoxylii*./ USA, Florida: 1882: on *Ilex glabra*: URM9951; LAM201563.

NEGER, F. W. Chile, Conception: November 1896: on *Litsiae caustica*: PAD*(ex Herb. Saccardo 2796); LAM201064: *Teichosporella negeriana*.

POHLAD, BOBBY RAY. #744. USA, Florida, Christmas, Philipps Farm: 20 May 1975: *Treubiomyces pulcherrimus*./ #479. USA, Florida, Tavares, United States Department of Agriculture orange grove: 22 April 1972: *Treubiomyces pulcherrimus*.

SEAVER, F. J. and C. E. CHARDON. #1316. USA, Porto Rico, Rio Peidras Experiment Station: 24 January - 5 April 1923: on *Erythrina glauca*: CUP*(ex The New York Botanical Garden and Department of Agriculture and Labor of Porto Rico, West Indian Exploration, Exploration of Porto Rico); LAM201004: *Phaeosaccardinula seaveriana*.

SILVA, S. J. da. Brasil, Pernambuco, Vitoria: on *Xanthoxylum rhoifolium*: URM2799*; LAM200956: *Ainsworthia xanthoxylii*.

STEVENS, F. L. Porto Rico, Rosario: 14 November 1913: on *Artocarpus incisa*: URM9226(exBPI); LAM200948: BPI; LAM201525: *Trichomerium*.

THEISSEN, P. Brasil, Rio Grande do Sul, São Leopoldo: 1908: FH*(ex Herb. Höhnel, ex Herb. Rehm); LAM201533: *Limacinula roseospora*. YAMAMOTO, W. Taiwan, Sintiku, Sansyuko: 19 March 1942: on *Citrus maxima*: TNU*; LAM201781: *Phaeosaccardinula longiospora*.

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STUDIES ON PARASITIC FUNGI FROM SOUTH EAST ASIA, 49. PARASITIC FUNGI FROM MALAYSIA, 25: SEMIPSEUDOCERCOSPORA GEN. NOV.

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INTRODUCTION

Cercospora peristrophes-acuminatae Yen (Yen, 1964) was described as a parasite on Peristrophe acuminata in Singapore. Dr. F.C. Deighton, CMI mycologist, critically examined the type material at the request of the author. He remarked (personal communication, 7 April 1981): "If I remember rightly, your Cercospora peristrophes-acuminatae has unthickened conidial scars and might therefore be better placed in Pseudocercospora. The short cylindrical pegs on which the conidia are borne, aggregated towards the tip of the conidiophores, are unlike what occurs in any other species I can think of. If one could find another species with these characters, it might be worth separating them into a new genus." Reexamination of Singapore collections in the Yen Herbarium resulted in no additional specimens with these characters. However, the special features of C. peristrophes-acuminatae noted above by Dr. Deighton merit the establishment of a new genus.

DESCRIPTION OF FUNGUS

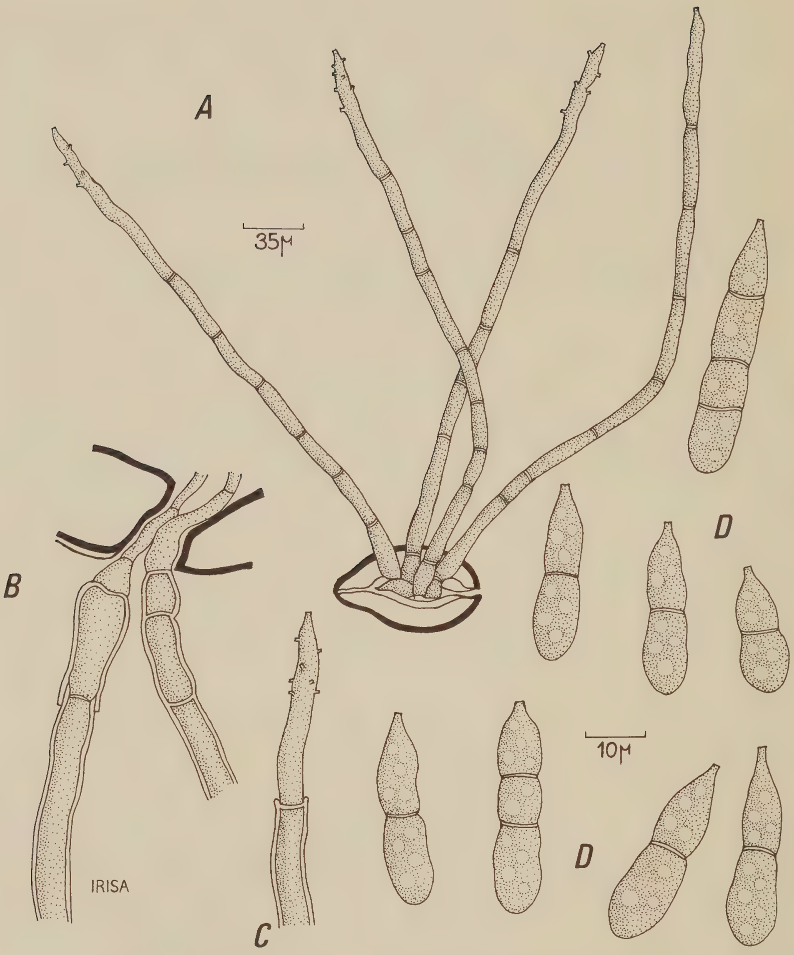
SEMIPSEUDOCERCOSPORA gen. nov.

Deuteromycotina, Hyphomycetes.

Maculis in foliis vivis, parasiticis. Mycelium immersum. Stromatibus nullis vel male evolutis. Conidiophoris macronematicis, mononematicis, in fasciculo per stomatibus emergentis, plerumque simplicibus, septatis, brunneis vel obscure brunneis, ad superne clavis brevis et cylindraceis aggregatis, conidiis ex clavis oriundis, cicatricibus conidialis non incrassatis. Cellulis conidiogenis polyblasticis, integratis, sympodialis. Conidiis acropleurogenis, solitariis, clavatis vel oblongatis, pallide olivaceis, septatis, laevis, hilum subtruncatum et non incrassatum.

Species typica: Semipseudocercospora peristrophes-acuminatae (Yen) Yen.

Leaf spot on living leaves, parasitic. Mycelium internal. Stromata none or rudimentary. Conidiophores macronematous, mononematous, in fascicles emerging through the stomata, simple, septate, brown to dark brown, forming towards the tip several short and cylindrical pegs on which the conidia are borne. Conidiogenous cells polyblastic, integrated, sympodial. Conidial scars not thickened, inconspicuous. Conidia acropleurogenous, solitary, clavate or oblong, pale olivaceous, septate, smooth, sometimes slightly constricted, with an unthickened and subtruncate hilum.


A
35μ
B
IRISA
C
D
10μ
D

Semipseudocercospora peristrophes-acuminatae(Yen)Yen: A, Conidiophores; B, Formation of conidiophores; C,Conidiogenous cell and formation of short pegs; D, Conidia.

Semipseudocercospora peristrophes-acuminatae (Yen) Yen, comb. nov.

= Cercospora peristrophes-acuminatae Yen, Revue de Mycologie, 29: 230, 1964.

Maculis indistinctis, interdum cum areis parvis, atro-brunneis et expers marginis. Caespitulis hypophyllis, raro amphiphyllis, invisibilis. Mycelium immersum: hyphis pallide olivaceis, septatis, ramosis, 2-3.5 µm latis. Stromatibus nullis. Conidiophoris plerumque hypophyllis, 2-8 in fasciculo per stomatibus emergentis, simplicibus, erectis, rectis, brunneis vel obscure brunneis, sursum pallidioris, 3-12-septatis, non geniculatis, ad superne 4-9 clavis brevis et cylindraceis aggregatis, conidiis ex clavis oriundis, cicatricibus conidialis non incrassatis, 156-295 x 6-7.5 µm. Conidiis breviter clavatis vel longum oblongatis, pallide olivaceis, rectis, laevis, 1-3-septatis, leniter constrictis, apice rotundatis, basi attenuatis et subtruncatis, hilum non incrassatum, 32-45 x 8-8.5 µm.

Habitat in foliis vivis Peristrophes acuminatae (Acanthaceae), ad Katong, Singapora, leg. Mrs. Shu-Hsien Yen, 20 IV 1964,No. 20 (Herb. LAM Yen #10624, holotypus).

Leaf spot none or indistinct, sometimes with small dark brown areas without distinct margin. Fruiting hypophyllous, rarely amphiphyllous, invisible. Mycelium internal: hyphae pale olivaceous, septate, branched, 2-3.5 µm wide. Stromata lacking. Conidiophores generally hypophyllous, 2-8 in fascicles emerging through the stomata, simple, erect, straight, brown to dark brown, paler and attenuate towards the tip, 3-12-septate, generally not geniculate, producing 4-9 short and cylindrical pegs aggregated towards the tip, on which the conidia are borne, conidial scars not thickened and inconspicuous, 156-295 x 6-7.5 µm. Conidia shortly clavate or long oblong, pale olivaceous, straight, smooth, 1-3-septate, sometimes slightly constricted at the septum, apex rounded, base attenuate and subtruncate, hilum not thickened, 32-45 x 8-8.5 µm.

On living leaves of Peristrophe acuminata (Acanthaceae), in Katong, Singapore, leg. Mrs. Shu-Hsien Yen, 20 IV 1964, No. 20 (Herb. LAM Yen #10624).

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COMPARATIVE PHYSIOLOGY OF SOME STRAINS OF ROLLANDINA
II. AMINO ACID METABOLISM

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SUMMARY

SEM studies of ascospore morphology of the type strains of *Pseudoarachniotus punctatus*, *P. marginosporus*, *P. hyalinosporus* and *Narasimhella poonensis* provided definitive evidence in support of positive relationships for these strains. Earlier morphological studies provided justification for acceptance of *P. marginosporus* *P. punctatus* and *N. poonensis* as synonyms of *Rollandina capitata*. *R. hyalinospora* differs from *R. capitata* on the basis of ascospore morphology. The present study provides biochemical evidence suggesting that these four strains originated from the same genetic stock and represent species of the genus *Rollandina* Pat. Amino acid metabolism of these strains were studied in glucose asparagine medium at different stages of growth.

Free and bound amino acids of the mycelia and free amino acids of the culture filtrates were analysed. Eighteen amino acids and two amides were detected. All four fungal strains were alike with respect to their Amino acid composition at different stages of growth. Specific variations were noted between the two species and among the clinical and saprophytic strains. Strain GR-6 is recognised as a variant strain of *R. capitata*.

On the basis of morphological characters Roy et al (1978) brought together *Pseudoarachniotus marginosporus* Kuehn and Orr; *P. punctatus* Dutta and Ghosh; *P.hyalinosporus* Kuehn et al and *Narasimhella poonensis* Thirum and Mathur under the single genus *Rollandina* Pat.

Ghosh et al (1979) studied comparative ascospore morphology of certain strains of Rollandina by scanning electron microscope. Their observations also support the above contention.

Mohanty and Ghosh (1979) carried out a comparative physiological study on four strains of Rollandina and observed that the three strains of R. capitata Pat. behaved alike in respect to their RNA make up. 'T' test conducted on the DNA content of the mycelia/mg dry weight supported the view that all four fungi belong to the genus Rollandina. Further, the dry weights of the mycelia for the saprophytic strains were greater than those of the clinical strains; so also for the cellular proteins; these being at the peak period of growth. The biochemical behaviour is genetically controlled and may have a bearing on taxonomy. The aim of the present investigation is therefore to clarify, further taxonomic confusion; the method employed being a comparative study of amino acid metabolism. In addition, the behaviour of the clinical strains was compared with that of saprophytic strains.

MATERIALS AND METHODS

The species and strains of fungi used in this study were: (1) R. capitata (GR-6, 0-112), (2) R. capitata (GR-29, 0-962, STM. F-223), (3) R. capitata (GR-42, 0-3540) and (4) R. hyalinospora (GR-52, 0-1247 STM F.231). The glucose-asparagine liquid medium of Lilly and Barnett (1951) was utilised throughout the present investigation. The pH was always adjusted to 6.5 Experimental procedure of Ghosh (1960) was followed which is briefly described below. Twenty-five ml. aliquots of the nutrient medium were distributed in 150 ml. Erlenmeyer flasks. The flasks were then autoclaved for 15 minutes at 15 lbs. pressure. The inocula were pregrown in 25 ml. shaken basal medium at 30°C in 150 ml. Erlenmeyer flasks. A 0.5 cm diam. platinum loopful of growth was used to inoculate all experimental flasks. The inoculated flasks were kept undisturbed for 12 h. Then they were incubated for nine days on a reciprocating shaker at 30°C (± 1°C). Incubation period was counted from the time the flasks were kept on shaker. In a previous study the authors noted (fig.1, Mohanty and Ghosh, 1979) lag phase to be negligible for these four fungi. Autolysis started after 3 days of incubation in strains GR-6 and GR-52. For strains GR-42 and GR-29 autolysis set on after the 4th and 5th days respectively. Therefore, in this investigation five growth phases 1st, 3rd, 5th, 7th and 9th days were chosen for analytical studies. At the end of each specific period of growth, flasks in triplicate, were removed from shaker. The flasks were then autoclaved briefly to kill the fungi. The growth was separated from the culture medium by filtration using tared filter papers.

Preparation of samples for amino acid analysis: The mycelial growth from the triplicate flasks were harvested at a time at the end of specific growth periods. These mycelial mats were used for extraction of free and bound form of amino acids. Amino acids from the mycelia and from the cultivation liquids were extrated following the method of Venkata Ram (1957).

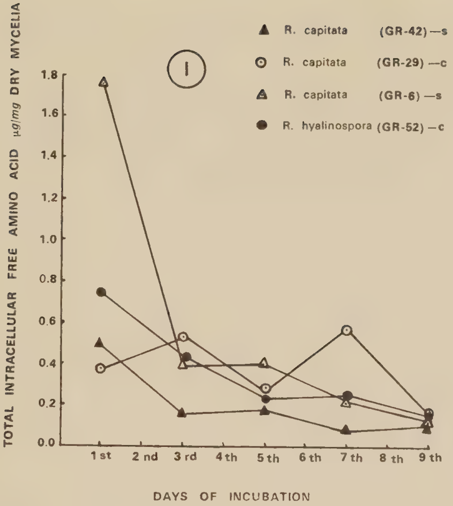
The free amino acids from the mycelia were extracted with 70% ethanol for 24 h at room temperature. The residues after removal of the free amino acids were then dried, ground to a fine powder and the powder hydrolysed at 110°C for 24 h with 6 N Hcl. This hydrolysate contains the bound amino acids of the mycelia. The ethanolic extracts, hydrolysates and the culture filtrates were evaporated to dryness on a hot-water bath. For chromatographic analysis amino acids were extracted with n-butanol: phenol (6:4) solution. Two dimensional descending paper-chromatography was employed for identification and separation. All analyses were carried out on Whatman No.1 Chromatographic-grade filter paper, using phenol:water (4:1) and butanol:acetic acid: water (BAN) (4:1:1) as the solvent systems. Quantitative estimates were carried out after the methods described by Giri et al (1952,1953).

RESULTS AND DISCUSSION

Eighteen amino acids and two amides were detected in the chromatograms of the mycelia and culture filtrates (Table 1). Their individual and total contents at different stages of growth are discussed below.

TOTAL AMINO ACID CONTENT OF THE MYCELIA AND GROWTH-MEDIA

Total free intracellular amino acids: The values for the four isolates of Rollandina at specific growth phases are shown in Fig.1. The pool was maximum on the 1st day for strains GR-6, GR-42 and GR-52. The values then dropped sharply upto the 3rd day and gradually upto the 9th day. This picture indicates early utilization of free amino acid pool during nitrogen metabolism. Strain GR-29 differed slightly. Differential behaviour of this strain is attributed to its late attainment of maximum growth on the 5th day (for the other three strains, peak period of growth was between the 3rd and 4th day). Pillai and Srinivasan (1956) reported free amino acid content in mycelia of Aspergillus flavus Link (grown as static culture in Czapek-Dox medium) decreased both during log and autolytic phases. Lahoz et al (1967) observed that in A. terreus Thom (grown in a physiologically acid medium as static culture) the disappearance of total free mycelial amino acid began before autolysis set in. With A. flavus grown in a physiologically alkaline medium under condition of continuous aeration and mechanical stirring, Lahoz and Ibeas (1968) again reported similar results. The present investigation supports these observations. Decrease in total free amino acids content, before the onset of autolysis, seems to be the common pattern for these fungi, irrespective of medium and conditions of growth. However, for Microsporum canis Bodin the maximum concentration of the amino acids pool was observed towards the end of the



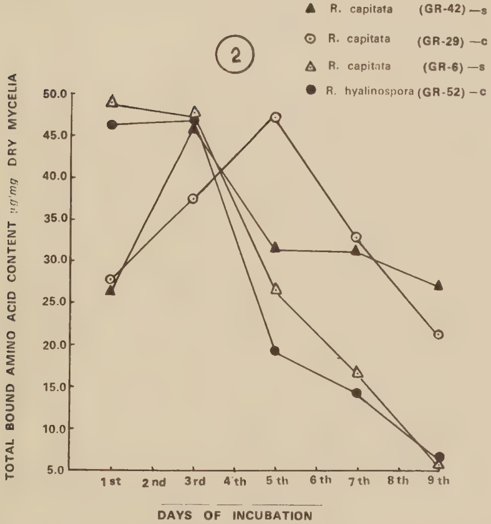


Fig.1.Total intracellular free amino acid contents of four isolates of *Rollandina* at specific growth phases.All isolates were grown in glucose asparagine medium.The total contents decreased during active growth. GR-29 differed by increasing until the 3rd da,then decreasing upto the 5th da, again increasing on the 7th da before finally dropping.

Fig.2.Total bound amino acid contents of four isolates of *Rollandina* at specific growth phases. The total contents increased during active growth.

log phase, with a decrease thereafter (Chattaway et al, 1962).

Total Bound amino acids: In the bound amino acid fraction of the mycelia the picture was different (Fig.2). Comparison of figs.1 and 2 shows that quantities of total free amino acids decreased during active growth with simultaneous increase in the bound form. This increase is quite concurrent with the increase in total nitrogen (unpublished data, Mohanty and Ghosh) and protein contents (Mohanty and Ghosh,1977) of these fungi during their peak periods of growth. Thus protein synthesis, in these four strains of Rollandina was preceded by an active synthesis of amino acids from asparagine. These amino acids were in turn immediately incorporated in bound form in the mycelia.

Total free amino acid contents of the culture filtrates:

Total quantitative values of the free amino acids are plotted in Fig.3. The values continuously increased upto the autolytic phase (5th and 7th day) and then dropped sharply on the 9th day. The general increase in the concentration of the amino acids and of the total nitrogen (unpublished data) towards autolysis is attributed to the proteolytic activity of the mycelia. The decline on the 9th day may be due to oxidation.

FREE AMINO ACIDS IN THE MYCELIA AND CULTURE FILTRATE

Mycelia: During active growth phase a wide array of amino acids in high concentration was detected in the ethanolic extracts of the mycelia (Table I). This indicates intense metabolic activity of the test fungi. These amino acids, synthesized from asparagine of the basal medium, are either directly incorporated into the proteins of the cells or used as a nitrogen source for the synthesis of other cellular constituents.

In general, the amino acids decreased both in number and quantity towards autolytic phase (Table 1). This decline is attributed to the decreased synthesis of protein or other nitrogenous substances during autolysis.

Asparagine was detected in maximum amount on the 1st day of active growth in GR-42, GR-29 and GR-52. The quantity thereafter decreased to the minimum. It was not present in GR-6 at any stage. This is possibly due to the extracellular conversion ability of the fungus. In the other three strains asparagine seems to have been absorbed into the cells and then immediately converted to other amino acids.

Alanine, glutamic acid and glycine were present in four fungi at all stages of growth. Distribution pattern of the other amino acids can be seen in Table 1.

The composition of the free amino acid pool, detected in four fungi, was similar to that reported for A. flavus (Pillai and Srinivasan, 1956).

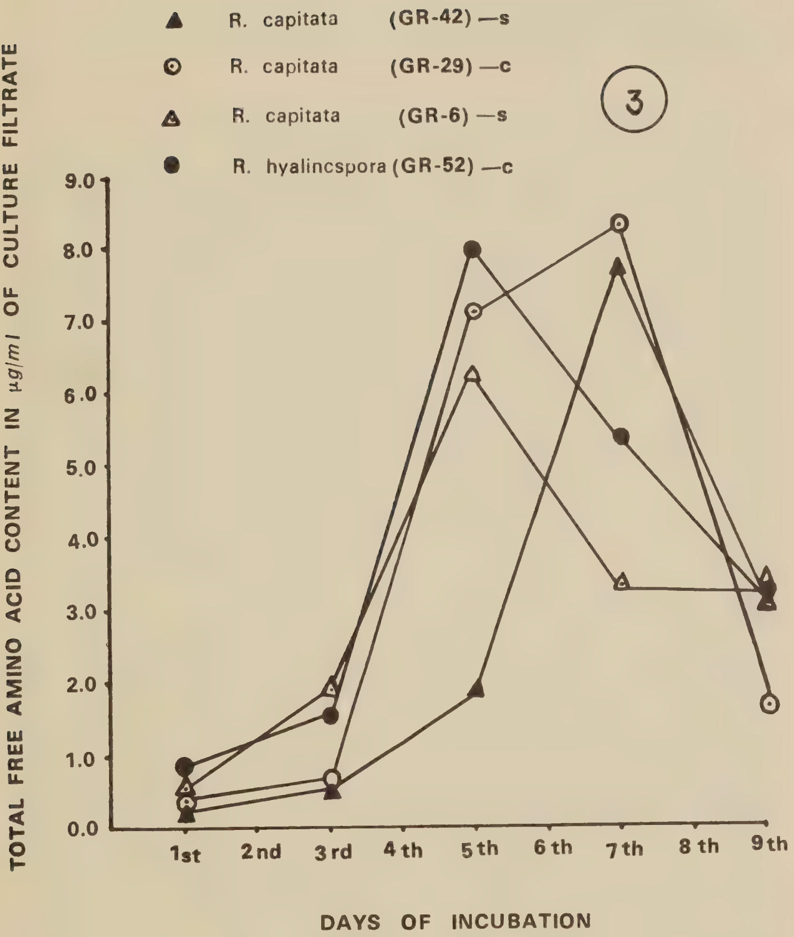


Fig.3.

Total free amino acid contents of culture filtrates from four isolates of Rollandina at five different growth phases. All were grown in glucose/asparagine medium. The values continuously increased upto the autolytic phase (5th & 7th da), then dropped on the 9th da.

CHROMOTAGRAPHIC ANALYSIS OF AMINO ACID POOL AT VARIOUS STAGES OF INCUBATION

AMINO ACID		DAYS OF INCUBATION																			
		1st				3rd				5 th				7 th				9 th			
	GR-	42	29	6	52	42	29	6	52	42	29	6	52	42	29	6	52	42	29	6	52
ALANINE	M	T	T	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	F	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ARGININE	M	+	+	−	+	+	+	+	+	T	+	+	T	+	+	+	T	T	+	+	T
	F	+	+	+	+	+	+	+	+	T	+	+	+	+	+	+	+	T	+	+	+
ASPARTIC ACID	M	+	T	+	T	+	+	+	+	T	T	+	+	T	T	−	+	T	−	−	+
	F	+	+	+	+	+	T	+	+	T	+	+	+	+	T	+	+	−	T	−	+
ASPARAGINE	M	+	+	−	+	+	+	−	+	T	+	−	−	T	T	−	−	T	T	−	−
	F	+	+	+	+	T	+	+	+	−	T	T	−	−	T	−	−	−	T	−	−
GLUTAMIC ACID	M	T	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	F	+	+	T	T	+	T	+	+	+	+	+	+	+	+	+	+	+	+	T	+
CYSTINE	M	−	−	−	−	−	−	+	T	−	T	+	+	−	−	+	+	−	−	−	−
	F	−	−	−	−	−	T	+	+	−	+	+	+	−	T	−	+	−	T	−	+
GLUTAMINE	M	T	+	+	T	T	+	+	−	T	−	+	+	T	+	−	−	T	−	+	−
	F	T	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	T	+	+	+
GLYCINE	M	+	+	T	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	F	T	+	T	T	+	+	+	+	T	+	+	+	+	+	+	+	T	+	−	−
ISOLEUCINE	M	−	−	−	−	−	−	−	+	T	−	−	−	T	−	−	−	T	−	−	−
	F	−	−	−	−	−	−	−	−	+	+	+	+	+	+	−	+	T	+	−	−
LEUCINE	M	T	T	+	−	T	+	+	+	+	+	+	+	T	+	+	+	T	+	+	+
	F	−	−	−	−	T	−	+	+	+	+	+	+	+	+	+	+	+	−	−	+
LYSINE	M	+	−	−	T	+	−	−	−	−	−	−	−	T	−	−	−	T	+	−	−
	F	−	−	−	−	T	−	+	+	T	+	−	+	−	+	−	−	+	+	+	+
HISTIDINE	M	−	−	+	−	T	−	+	−	T	+	+	+	−	+	−	−	−	T	+	−
	F	−	−	−	−	−	−	+	+	+	+	+	+	+	+	+	+	−	−	−	−
PROLINE	M	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	−
	F	−	−	−	−	−	−	−	+	T	T	+	+	T	−	+	+	−	+	+	−
PHENYLALANINE	M	−	−	−	−	−	−	−	+	T	T	−	T	T	+	+	−	T	T	−	T
	F	−	−	−	−	−	−	T	T	−	−	+	T	T	+	+	T	−	+	+	−
METHIONINE	M	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−	T	−	−	−	−
	F	−	−	−	−	−	−	+	T	+	+	+	+	+	+	+	+	T	−	−	−
TRYPTOPHAN	M	−	−	−	−	T	T	+	+	+	+	+	T	+	+	−	−	T	+	−	−
	F	−	−	−	−	T	−	+	+	+	+	−	+	+	+	+	+	+	T	−	−
THREONINE	M	−	−	−	−	−	+	−	+	−	−	−	−	−	T	+	−	T	+	−	−
	F	−	−	−	−	T	−	−	−	−	+	+	+	T	+	−	−	T	−	T	+
TYROSINE	M	−	−	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−
	F	−	−	−	−	−	−	−	−	−	+	−	−	−	−	+	+	−	T	−	−
SERINE	M	T	T	+	+	T	+	+	+	T	+	+	+	−	+	+	T	−	+	+	+
	F	−	T	−	−	−	T	+	+	T	+	+	+	T	T	+	+	−	+	−	+
VALINE	M	−	−	+	−	T	+	+	+	+	+	+	+	+	+	−	+	+	+	−	+
	F	−	−	−	−	T	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+

+ = PRESENT   − = ABSENT   T = TRACE   M = MYCELIA   F = FILTRATE

Table 1

FREE AMINO ACIDS DETECTED IN THE MYCELIA AND CULTURE FILTRATES OF ROLLANDINA CAPITATA (GR-42, GR-29 AND GR-6) AND R. HYALINOSPORA (GR-52)

Strains GR-29, GR-52 are clinical, GR-6, GR-42 are Saprophytic, while GR-6 is a Variant. Strain GR-52 differed from the rest in having good amount of isoleucine, phenylalanine and tyrosine during its active growth phase. In the similar manner proline and tyrosine were respectively detected only in the clinical strains GR-29 and GR-52

In general the four strains behaved alike in their free amino acid pool composition. However, R. hyalinospora (GR-52) differed from the three strains of R. capitata (Table I).

The clinical strains (GR-29 and GR-52) showed some specificity over the saprophytic strains. Threonine, methionine and cystine were recorded in GR-29 and GR-52. These amino acids were completely absent in the saprophytic strains except in GR-6 for cystine. This strain was all the time behaving erratically and is recognised here as a variant. Hydroxyproline was not detected at all (Table I).

Culture filtrate: On the 1st day of incubation the two amides and five amino acids (alanine, aspartic acid, glutamic acid, arginine and glycine) were common for all the four fungi (Table I). These are considered to have originated from asparagine. Presence of aspartic and glutamic acids is noteworthy since these are important parental sources for other amino acids. These two parental amino acids in turn are considered to have originated from asparagine.

The number and quantity of amino acids continuously increased upto the autolytic phase (5th and 7th day) and thereafter dropped.

BOUND AMINO ACIDS OF THE MYCELIA

Only 17 amino acids and no amides were detected in the mycelial protein hydrolysates. The amino acid composition of the proteins was alike in the four fungi, though the quantity varied during the period of incubation. Hydroxyproline was not detected. This is in agreement with the observations of Hare (1953) for eight dermatophytes. Similar results were obtained by Kashyap et al (1972) for Arachniotus dankaliensis (Cast) Van Beyma (=Trichophyton dankaliensis Cast) and by Pillai and Srinivasan (1956); Lahoz and Ibeas (1968) for species of Aspergillus. Hydroxyproline is reported to be inhibitory to the growth of dermatophytes (Shome, 1967).

The nature of the amino acid pool needed for protein synthesis, is reflected in the bound amino acid fractions. From among the bound amino acids, aspartic acid, leucine, glutamic acid and glycine were detected in higher concentration. This is in accordance with Hare's (1953) observation. Thus these amino acids form bulk of the pool from which protein synthesis occurs. Since asparagine was the sole source of nitrogen in the medium, its conversion into other principal amino acids must have preceeded active synthesis of proteins. Simultaneously, analysis of the ethanolic extract of the mycelia and cultivation media during different stages of growth reflected the amino acid status of the mycelia. These analyses also revealed gradual accumulation of various amino acids incorporated in the protein synthesis. This suggests utilization of various amino acids as growth proceeded and indicates a constant pool at equilibrium with synthesis of proteins. Conversion of asparagine into the other amino acids would suggest the presence of an active deaminase system, along with several transaminases.

In general the quantity of individual amino acids increased during active growth phase and then gradually decreased during autolysis upto the 9th day. The mycelial proteins were affected by autolysis. It was interesting to note that amino acids like phenylalanine, proline, tyrosine, threonine, metheonine, isoleucine and lysine were present in measurable quantities in the mycelial protein whereas their quantities in the ethanolic extract were very low (Table I). The efficient incorporation of these amino acids into cellular protein soon after their formation would possibly explain this situation. In GR-42, the sulphur-containing amino acids, cystine and methionine were present in the bound form while they were absent in the free form. This suggests that strain GR-42 is incorporating these amino acids into the cellular proteins soon after their synthesis leaving none in the free form in the mycelia. Glutamine was found in the free form but in all cases was absent in the insoluble fraction (Table I).

No remarkable differences, qualitative or quantitative were observed in the amino acid composition of the four fungi. This is in accordance with Hare (1953) for eight dermatophytes and for Aspergillus glaucus Link reported by Work and Dewry (1953). The present study detected in addition, isoleucine and phenylalanine and is in agreement with Pillai and Srinivasan (1956) for A. flavus Link. However, histidine, though recorded in the present study and in the dermatophytes (Hare, 1953) was not detected in A. flavus.

Ghosh (1960) reported that some members of the Gymnoascacea have nutritional requirements closer to the Trichophytoneae than to the Aspergillaceae, while others had requirements similar to the Aspergillaceae. Kashyap et al (1972) reported on the nitrogen metabolism of Arachniotus dankaliensis (Cast) Van Beyma and remarked that the Trichophytoneae shows an utilisation pattern which is quite exclusive. Growth of A. dankaliensis was poor with dl-leucine, l-histidine and dl-proline. But l-histidine was indispensable for the growth of Trichophyton magnine Blanchard and one strain of T. violaceum Sabouraud apud Bodin; lecuine was one of the most utilisable amino acids for T. persicolor Sabouraud. Most of the isolates of T. tonsurans Malmsten were found not to be deficient for any one amino acid. However, l-arginine, l-ornithine, l-proline, dl-serine and dl-alanine stimulated growth more than any other amino acids tested. For Microsporum cookii Ajello and M. distortum DiMenna and Marples growing in shaken liquid medium, tyrosine was the best nitrogen source. But tyrosine was not detected in the mycelia of A. dankaliensis.

The bound amino acids detected during active growth phase of four fungi give the following picture when arranged in order of their quantity(Table II).

Table II

Alanine = GR-6 > GR-52 > GR-29 > GR-42
Arginine = GR-52 > GR-6 > GR-42 > GR-29
Aspartic acid = GR-42 > GR-29 > GR-6 > GR-52
Glutamic acid = GR-29 > GR-42 > GR-6 > GR-52
Cystine = GR-6 > GR-52 > GR-29 > GR-42
Glycine = GR-29 > GR-52 > GR-6 > GR-42
Iso-leucine = GR-29 > GR-52 > GR-6 > GR-42
Leucine = GR-42 > GR-29 > GR-52 > GR-6
Lysine = GR-52 > GR-6 > GR-29 > GR-42
Histidine = GR-6 > GR-42 > GR-52 > GR-29
Proline = GR-6 > GR-52 > GR-42 > GR-29
Phenylalanine = GR-6 > GR-52 > GR-29 > GR-42
Methionine = GR-52 > GR-6 > GR-29 > GR-42
Threonine = GR-42 > GR-29 > GR-6 > GR-52
Tyrosine = GR-6 > GR-52 > GR-29 > GR-42
Serine = GR-29 > GR-42 > GR-52 > GR-6
Valine = GR-29 > GR-42 > GR-52 > GR-6

As seen in Table II GR-29 and GR-42 follow each other closely and differ from GR-6. This being on the basis of their quantitative bound amino acid content. For sharing similar morphological and cultural characters GR-29 and GR-42 were grouped by Roy (1978) into one category along with other strains. These strains produced stalked ascocarps of medium size (114-578 x 171-850 um) and small asci (5.5-8.4 x 6.6-9.8 um) and small ascospores (2.2-4.2 x 3.3-4.5 um). Strains GR-29 and GR-42 produced the characteristic green pigmentation on three out of four media. Tufted growth was observed in one (GR-29) or two (GR-42) media only. They did not produce sectors on any of the four media. GR-6 was excluded because it differed distinctly from them. It did not produce discrete ascocarps; asci in small clusters (20-140 um diam) were scattered among vegetative hyphae. This is the only strain which produced tufted growth on all four media. However it had small ascospores in small asci. Green pigmentation was observed in one medium and sectors produced on two. For these differential behaviour, strain GR-6 is recognised as a variant strain of R. capitata.

A comparision of the possible enzymatic make-up of the four strains with particular reference to the members of the aspartate family reveals that it is similar in general. During the active growth phase the synthesis of aspartic acid and glutamic acid and their transaminated derivatives occur quite rapidly in all the four strains. However, slight differences are obseravable with relation to the formation and utilization of methionine, isoleucine and threonine. For example, metheonine is synthesized in limited amount in the strains GR-29 and GR-42 and gets immediately incorporated into proteins leaving no trace whatsoever in either the filtrate or the mycelium. However, after the 3rd day or even during 3rd day methionine can be detected in culture filtrates of strains of GR-6 and GR-52. On the 5th day onwards methionine appears in the filtrate as well as in mycelium of strains GR-29, GR-42 and GR-52. But it remains absent in the mycelia of GR-6 till the unset of autolysis.

With regard to isoleucine also similar marginal variation can be noted. In this case, it is the strain GR-52 which shows relatively higher rate of isoleucine formation as evidenced in its passage in the culture filtrate; 5th day onwards this appears in filtrate and mycelium of all the strains. For threonine there is an evidence of enhance synthesis in strains GR-42, and GR-29 upto the 3rd day followed by an accumulation of this amino acid in the culture filtrates of these strains 5th day onwards. There is slight accumulation in GR-52 and GR-6 also.

A variation in metabolism is discernible with regard to lysine . It appears that at no stage in any of the four strains this amino acid is synthesized appreciably. And that whatever amount formed is utilized immediately resulting in to very small mycelial pool size. Accumulation in culture filtrate is also marginal.

Overall, it can therefore be suggested, strains GR-29 and GR-42 are noticeably similar and consistent in their metabolism of the amino acids of the aspartate family than the strains GR-6 and GR-52. It can also be said that the strains GR-6 and GR-52 differ slightly from these in regard to synthesis of methionine. Further, the strain GR-52 varies marginally from others in the transformation of aspartate to isoleucine and threonine, is also evident.

The exact nature of the marginal differences is under investigation.

That the enzymatic make-up in all these four strains, as it can be elucidated on the basis of the nature of asparagine utilization, is also reflected in their very similar growth patterns (Mohanty and Ghosh, 1979), all of which are remarkable in not showing even a rudimentary lag phase.

Specific variation between clinical and saprophytic strain was noted. Tyrosine, proline, threonine, methionine and cystine were present in free amino acid fraction of the mycelia in the former strains only during their peak growth periods. This confirms that metabolic patterns are intrinsically related to the nature of growth. Consequently this will have other physiological manifestations such as pathogenicity. This was earlier pointed out by Kashyap et al (1972). Such biochemical investigation on the metabolism of these organisms are destined to play a major role in medical mycology. However, similar biochemical behaviour noted at large, in the present study supports that all four strains orginated from the same genetic stock and represent species of the same genus Rollandina Pat.

ACKNOWLEDGEMENTS

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OBSERVATIONS ON THE BOLBITIACEAE - 22

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SUMMARY

Several members of the Bolbitiaceae are recorded for the eastern United States, some apparently new to the area. The records include three new species, *Agrocybe smithii, A. occidentalis,* and *Conocybe marginata;* an unidentified taxon of *Conocybe* also is included in the discussion.

INTRODUCTION

The family Bolbitiaceae has been neglected by North American agaricologists probably because the basidiomes of constituent members are usually small, an uninteresting uniform brown, and appear at first sight not to play any important role in the grassland or woodland communities. They are not known to be either mycorrhizal or parasitic, but of course they do contribute as saprobes in the breakdown of organic debris.

Over the last twenty-five years the junior author has amassed a large collection of agaricoid fungi from the eastern states of North America, and the bolbitaceous material has been made available to RW for examination. The results of this examination are reported herein; collections are deposited in MASS unless otherwise stated.

Three species are new, and information is offered on the occurrence of nine other taxa.

AGROCYBE

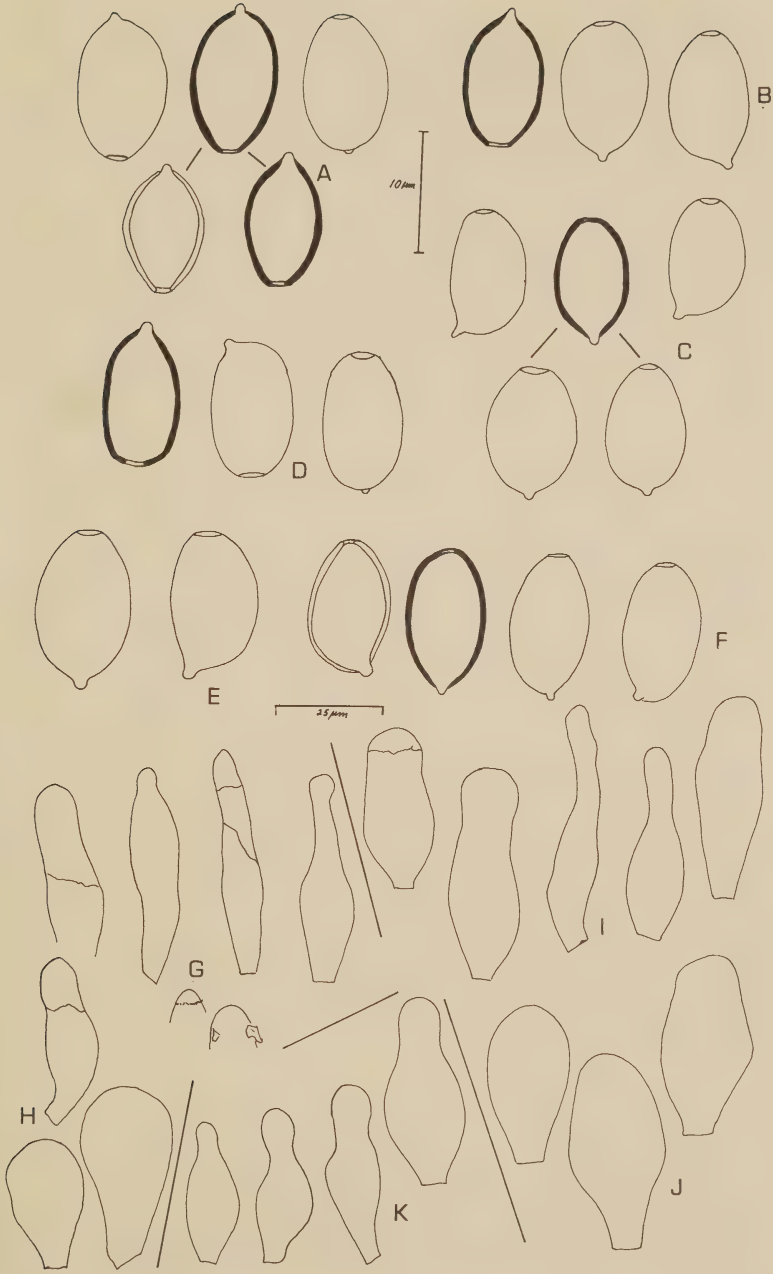
AGROCYBE SMITHII Watling & Bigelow, sp. nov.
Plate 1, Figs. E, I, J, Plate 4

Pileus 20-70 mm latus, convexus dein plano-convexus, olivaceus ad violaceo griseus, demum alutaceus, in vetustae discus interdum brunneus vel luteo-alutaceus, primum subviscidus, glaber, in vetustae rimosus, haud striatus. Stipes 20-65 mm longus, 10-20 mm crassus, deorsum clavatus vel subbulbus, interdum compressus (<35 mm crassus), interdum flexosus, carnosus (pileo concolore) vel pallide alutaceus, demum sordidus, apex pruinosus, deorsum striatus et scabrosus. Lamellae adnatae vel emarginatae vel subdecurrentes, confertae vel confertissimae, atro-alutaceae, tandem cinnamomeo-brunneae, angustae ad sublatae. Caro albida, tenax. Odor farinaceus vel fragrans. Sapor farinaceus.

Sporae 11-13.5 x 6.5-8 μm, ellipsoidae ad subovoidae, parietes incrassatae, leves. Pleurocystidia saccata ad vesiculosa, levis, vel apices incrustatae, 26-36(-48) x 11-21(-25) μm. Cheilocystidia saccata vel ± ampulliformia, levis vel apices cum mucilaginosum collum vel granulia, cheilocystidia 26-38(-57) x 8-14 μm, apices 4-6(-8.5) μm. Hyphae fibulatae. Cuticularis cellulosus pileus clavato-pedicellatus, 15.5-22 x 7-15 μm latae.

Holotypus: United States, Massachusetts, Hampshire Co., Amherst, near Clark Hall, University of Massachusetts, 9 June 1967. H. E. Bigelow n. 15007 (MASS, E).

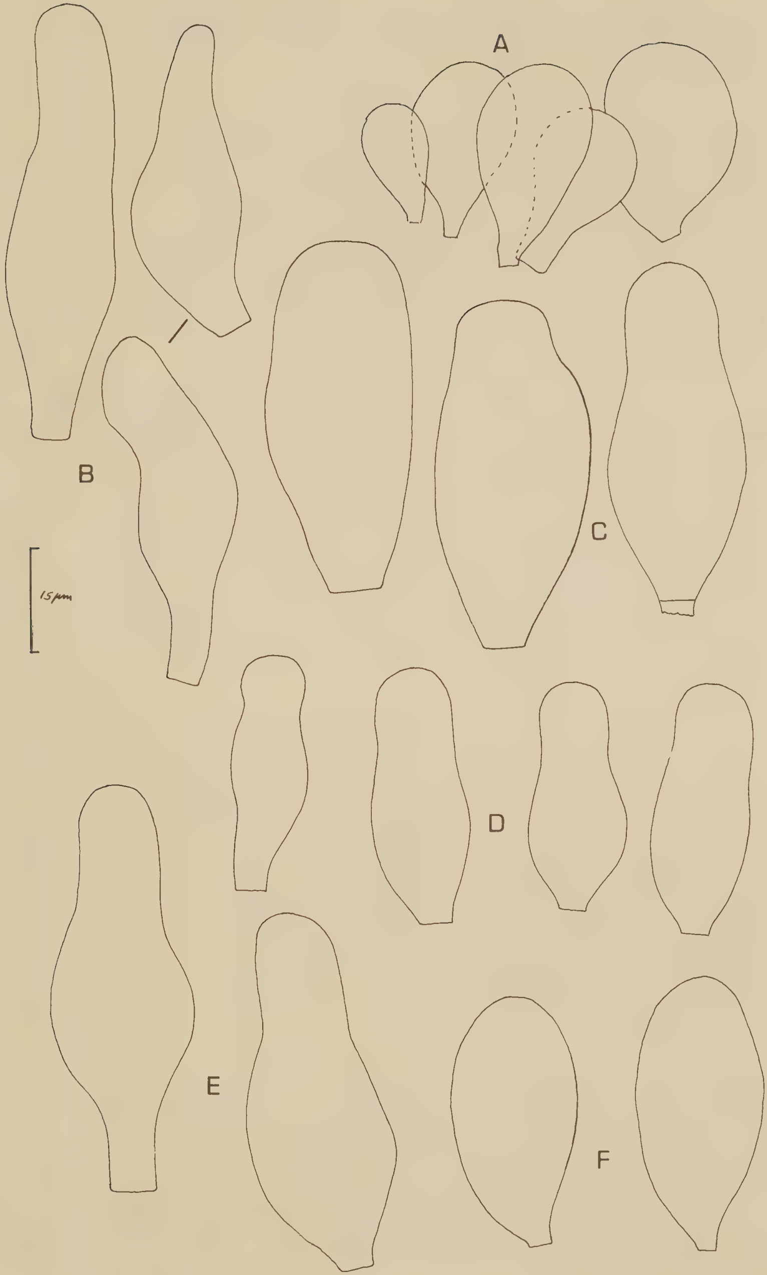
Plate 1. Figs. A-F. Basidiospores (all type material). A. *Agrocybe hortense*; B. *A. amara*; C. *A. farinacea*; D. *A. sororia*; E. *A. smithii*; F. *A. occidentalis*. Figs. G & H. *A. farinacea* (isotype): G. cheilocystidia; H. pleurocystidia. Figs. I & J. *A. smithii* (type): I. cheilocystidia; J. pleurocystidia. Fig. k. cheilocystidia in *A. occidentalis*.


A
B
10 µm
C
D
E
F
25 µm
G
I
H
J
K

Pileus 20-70 mm, convex then plano-convex with incurved, inrolled margin, olivaceous to violaceous gray at first, then grayish alutaceous, soon faded to alutaceous, sometimes ochraceous brown at center in age or uniformly yellowish alutaceous, subviscid at first especially toward margin, glabrous, sometimes rimose at center with age, nonstriate. *Stipe* 20-65 x 10-20 mm, clavate to subbulbous, sometimes compressed (<35 mm), flexuous at times, fleshy, concolorous or pale alutaceous, becoming pale dingy alutaceous, pruinose at apex, ± striate below, with scattered scabrosities. *Gills* adnate or emarginate, or with decurrent tooth, close or crowded, dark alutaceous, finally ± cinnamon brown, narrow to moderately broad. *Flesh* white, tough. *Odor* rather fragrant-fungoid or farinaceous when crushed, ± rancid with age; taste farinaceous.

Basidiospores 11-13.5 x 6.5-8 µm, ellipsoid to subovoid, slightly compressed in profile, fulvous in water, slightly darker in 3% KOH, smooth, thick walled, apiculus prominent, germ pore prominent; spore deposit "Prout's Brown", "Bister", "Verona Brown", "Warm Sepia". *Basidia* 4-spored, clavate, hyaline or slightly yellowish in water and alkali solutions. *Pleurocystidia* 26-36(-48) x 11-21(-25) µm, prominent, saccate to vesiculose, smooth or with apical deposits, hyaline or at most slightly yellowish in 3% KOH, sometimes as small yellowish basidiole-like structures. *Cheilocystidia* very variable, forming a prominent sterile edge, 26-38(-57) x 8-14 µm, apex 4-6(-8.5) µm, saccate or ± ampulliform, smooth or frequently with mucilaginous collar or minute granulations on apex, hyaline to distinctly yellowish in 3% KOH, with a silvery honey-colored collar. *Hymenophoral trama* regular with pale honey-colored mediostratum and darker lateral strata. *Pileipellis* a palisadoderm of hyaline, clavate-pedicellate cells, 15.5-22 x 7-15 µm, not intermixed with pilocystidia. *Clamp connections* present; oleiferous hyphae present in both pileus and hymenophoral tramas, yellowish in 3% KOH.

Plate 2. Fig. A. Pileipellis characteric of *A. sororia* group. Figs. B & C. *A. amara* (type): B. cheilocystidia; C. pleurocystidia. Fig. D. cheilocystidia in *A. hortense* (type). Figs. E & F. *A. sororia*: E. cheilocystidia; F. pleurocystidia.


A
B
C
D
E
F
15 μm

Solitary, gregarious, or scattered-cespitose on and amongst woodchips under *Eleagnus* or on manured soil.

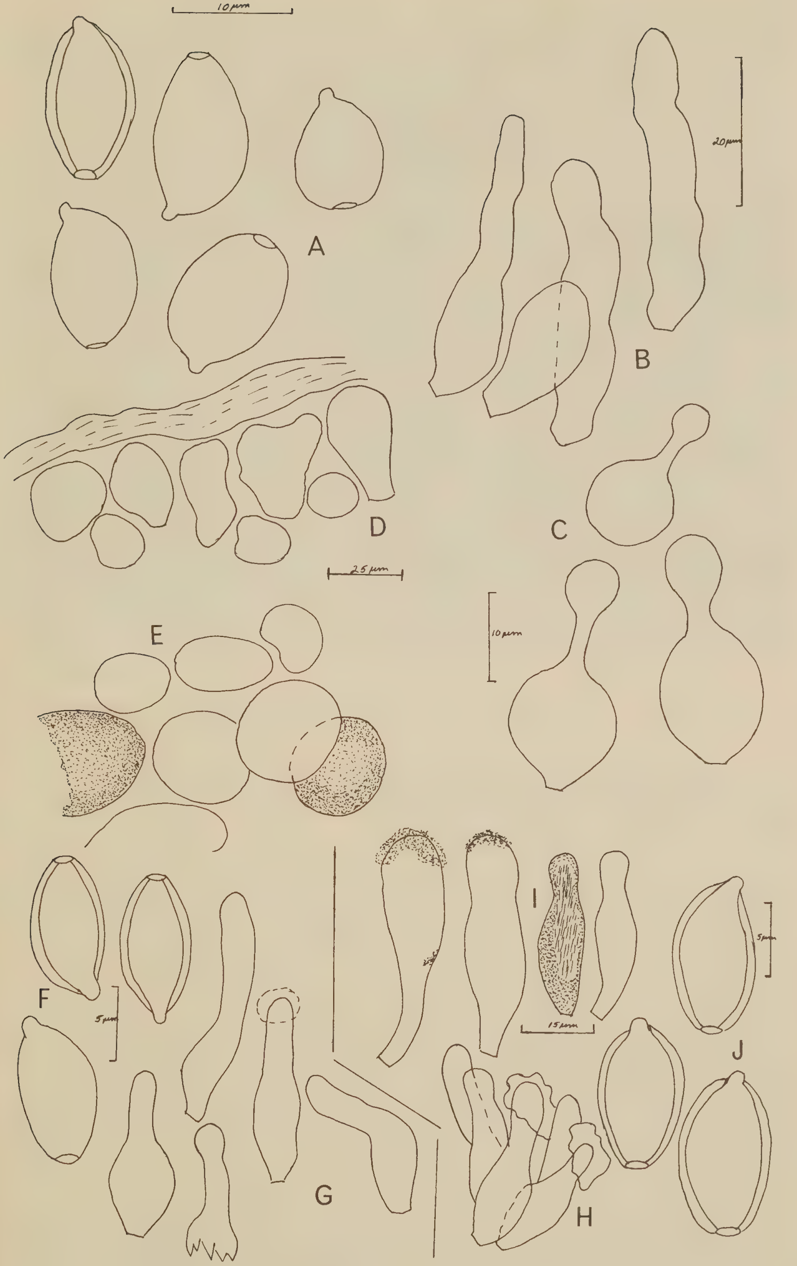
Material examined:

United States: Massachusetts: Hampshire Co., Amherst, near Clark Hall, University of Massachusetts, 30 April 1967, Bigelow 15003; same site, 9 June 1967, Bigelow 15007 (Holotype) (duplicate in E); Bigelow 15008 (duplicate in E); same site, 20 April 1968, Bigelow 15402 (duplicate in E); Franklin Co., Conway, Baptist Hill, 27 June 1971, Bigelow 16444; Hampshire Co., Amherst, President's Garden, University of Massachusetts, 21 May 1970, Bigelow 16133.

This species grew abundantly during 1967 and 1968 amid soil and wood chips around a new planting of *Eleagnus angustifolia* saplings. In the years since the area has become grassy and the agaric has not reappeared. The other Amherst site had a similar woodchip mulch, but many different plants were present. Although a number of shrubs and trees on the Amherst campus also have a woodchip mulch at their bases, *A. smithii* has not appeared elsewhere. The final collection at Conway, Massachusetts, about 15 miles away from Amherst, was made at the edge of a manured cornfield.

Agrocybe smithii is a member of the *A. sororia* complex of species which is characterized by the lack of a partial veil and by the presence of relatively short, broadly ellipsoid to ovoid spores that have a distinct germ pore. In addition, there are large, rather inflated cheilocystidia which are ± utriform. Pleurocystidia may be similar to cheilocystidia or they can vary in shape. Besides *A. smithii*, the *A. sororia* complex consists of *A. putaminum*, *A. hortense*, *A. farinacea*, *A. amara*, and *A. sororia*. A comparison of *A. smithii* to the other members of the complex follows:

Plate 3. Figs. A-E. *Conocybe* sp., Bigelow 8075: A. basidiospores; B. caulocystidia; C. cheilocystidia; D. LS of pileipellis; E. 'scalp' of pileus. Figs. F & G. *Conocybe marginata* (type): F. Basidiospores; G. cheilocystidia. Figs. H-J. *Agrocybe putaminum* (Bas 1051): H. cheilocystidia; I. pleurocystidia; J. basidiospores.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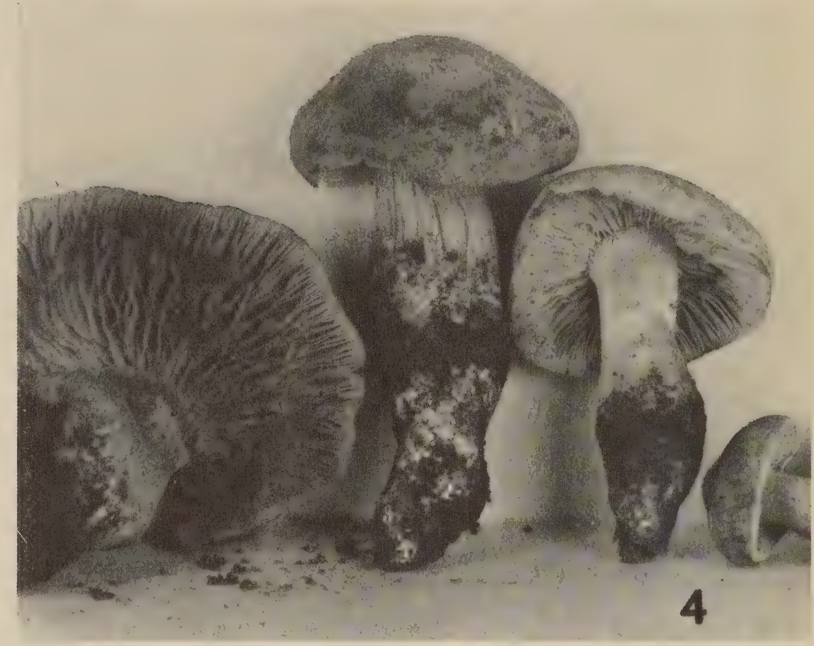

Plate 4. *Agrocybe smithii* X 1.

Agrocybe putaminum (Maire) Singer, Beih. Bot. Centralbl. 56B: 167. 1936.

Plate 3, Figs. H, J

Basidiospores 10-13.5(-15.5) x 6-7.5(-9.5) μm, ellipsoid, smooth, thick walled, apiculus prominent, germ pore prominent. Pleurocystidia broadly clavate to utriform, 45-60 x 12.5-20 μm, with pedicel seated in hymenophoral trama and apex frequently covered with granulations (crystals?) or narrowly clavate to cylindric, 38-60 x 5-15 μm, and then sometimes filled with yellow contents in aqueous mounts. Cheilocystidia 30-45 x 10-14 μm, ventricose-fusiform to lageniform, intermixed with some almost utriform cells, often ornamented with a distinct mucilaginous cap, hyaline in water or 3% KOH.

This Agrocybe is close to *A. smithii* in many features, but *A. putaminum* has pleurocystidia that are distinctly different in size and shape from those of *A. smithii* (cf.

Pl. 1, figs. I, J with Pl. 3, figs. H, I). *Agrocybe putaminum* also has pilocystidia, and these are absent in *A. smithii*. According to Bas (1958) the taste is bitter-farinaceous, not merely farinaceous as in *A. smithii*.

Agrocybe putaminum was first recorded as attached to fruits of members of the Rosaceae (Maire, 1913), although it has been found since on garden soil intermixed with straw and manure (Bas, 1958) and on woody debris (Colin and Josserand, 1967, 1968). The Bas collection (Netherlands, Leiden, Nachtigaal laan, 23 July 1956; Bas 1051 in L) has been examined by the senior author.

Agrocybe hortense (Burt) Singer, Sydowia 30: 202. (1977) 1978.

Plate 1, Fig. A; Plate 2, Fig. D.

Basidiospores 11-12.5(-13) x (6-)7-8 μm, ovate in face view, elliptical or slightly flattened on one side in profile, wall thick, pale ochraceous in water, yellow brown or tawny in 3% KOH, germ pore distinct, apiculus small, ("Roods Brown" in deposit sec. Burt, 1919). *Basidia* 4-spored, 18-28(-34) x 7.5-9 μm, clavate pedicellate, hyaline in water or 3% KOH. *Pleurocystidia* rare or absent, broadly clavate, or ventricose near base (10-17 μm broad) and hardly narrowed to broadly rounded apex. *Cheilocystidia* scattered, utriform to ventricose, 28-38(-40) x 11-25 μm, usually with broadly rounded apex, thin walled, smooth, hyaline in both water and 3% KOH. *Hymenophoral trama* of interwoven mediostratum and parallel lateral strata of cylindric hyphae 5-12.5 μm broad; subhymenium reduced, pale dingy yellow in 3% KOH. *Pileipellis* a palisadoderm of clavate-pedicellate, yellowish, thin-walled cells. *Pileus trama* of floccose-interwoven hyphae 2.5-10 μm broad. *Clamp connections* present; *oleiferous hyphae* present and abundant in some specimens. Material: Holotype - FH, MICH, slide in E.

As far as we are aware this species has not been collected again. It occurred abundantly in manured beds (cultivated borders where straw manure had been worked into the ground) at the Missouri Botanical Garden, St. Louis, Missouri after prolonged June rains. Burt (1919) placed this taxon in *Hebeloma* saying 'this species is noteworthy in its genus (*Denudata*) by absence of viscidity and odour of radishes and by its large size and occurrence in abundance in cultivated gardens.....Fresh specimens have a pleasant farinaceous taste and odour, and keep well. This species is edible and with a pleasant and distinctive odour.'

The type collection of *Hebeloma hortense* now deposited at FH is large and consists of many specimens; material was also communicated to C. H. Kauffman with specimens deposited at MICH; both collections have been examined.

Agrocybe smithii and *A. hortense* are similar in most field characters as well as growing in the same type of habitat. *Agrocybe smithii* lacks the umbo described by Burt (1919) for *Hebeloma hortense*, and the stipe width is markedly different (4-10 mm for *H. hortense*). However, such features can vary and it remains for future collections to determine whether or not these differences are consistent and will allow a separation of the two species in the field. The reliable means of recognition is provided by the virtual absence of pleurocystidia in *A. hortense*, and by the presence of broader cheilocystidia than found in *A. smithii*.

Agrocybe amara (Murrill) Singer, Lloydia 5: 134. 1942.
Plate 1, Fig. B; Plate 2, Figs. B, C.

Basionym: *Naucoria amara* Murrill, North Amer. Flora 10: 176. 1917.

Synonym: *Agrocybe sororia* var. *amara* (Murrill) Singer, Sydowia 30: 206. (1977) 1978.

Type data: New York Botanical Garden, 2 July 1915. On manure under trees (NY).

Basidiospores 9-11 x 5-6.5 µm, ovoid to ellipsoid, slightly flattened on one side in profile, dingy ochraceous in 3% KOH, slightly paler in water, thick walled, smooth, with distinct germ pore. *Basidia* 4-spored, 20-27.5 x 6-8 µm, clavate, hyaline in both water and 3% KOH. *Pleurocystidia* scattered, 30-55 x 10-20 µm, saccate, often with pedicel originating in lateral stratum, hyaline to pale ochraceous in water or 3% KOH, smooth, thin walled. *Cheilocystidia* ventricose-lageniform, similar to, although more variable in shape than pleurocystidia. *Hymenophoral trama* with central interwoven strand, pallid ochraceous in water and 3% KOH. *Pileus trama* floccose and interwoven. *Pileipellis* a palisadoderm of clavate-pedicellate cells, lacking pileocystidia. *Clamp connections* present.

Agrocybe farinacea Hongo, J. Jap. Bot. 32: 143. 1957.
Plate 1, Figs. C, G, H.

Synonym: *Agrocybe sororia* var. *farinacea* (Hongo) Singer, Sydowia 30: 206. (1977) 1978.

Type data: Japan, Otsu, Ishiyama-Senjo, 29 May 1956. On vegetable manure heap, especially on rice-hulls.

Basidiospores 8.5-10.5(-12) x 6-8(-8.5) µm, ovoid to ellipsoid, slightly flattened on one side in profile, pale ochraceous in water, slightly darker in 3% KOH, thick walled, smooth, with distinct germ pore. *Basidia* 4-spored, clavate pedicellate, hyaline in both water and 3% KOH. *Pleurocystidia* scattered, 40-50 x 19-25 µm, ventricose fusiform with obtuse apex or vesiculose, hyaline in both water and 3% KOH, smooth, thin walled. *Cheilocystidia* numerous, 32-55 x 12-30 µm, ventricose fusiform with obtuse apex, smooth or encrusted on apex, thin walled. *Hymenophoral trama* a regular floccose, honey-colored central zone with reduced subhymenium lateral stratum. *Pileus trama* of floccose interwoven hyaline or honey-colored hyphae. *Pileipellis* a palisadoderm of pyriform cells 15.5-30 µm broad, with scattered protruding *pilocystidia* 35-50 x 7.5-12.5 µm. *Clamp connections* present.

Agrocybe sororia (Peck) Watling, Kew Bull. 31: 592. 1977.
Plate 1, Fig. D; Plate 2, Figs. A, E, F.

Basionym: *Naucoria sororia* Peck, Bull. Torrey Bot. Club 34: 101. 1907.

Type data: Falmouth, Massachusetts, July, S. Davis. Solitary or gregarious on open grassy places (NYS).

Basidiospores 8-11 x 6-7 µm, ovoid to ellipsoid, elliptic in profile, ochraceous in water, dull ochraceous brown in 3% KOH, smooth, thick walled, with distinct germ pore. *Basidia* 4-spored, 25-30 x 8-10 µm, hyaline or slightly yellowish in water and 3% KOH, clavate pedicellate. *Pleurocystidia* scattered, 32-50 x 12-20 µm, saccate to clavate, others ventricose and resembling cheilocystidia, hyaline in water and 3% KOH, thin walled, smooth. *Cheilocystidia* 30-40 x 12-15 µm, ventricose with obtuse apex. *Hymenophoral trama* with filamentous ± interwoven hyphae. *Pileus trama* of floccose interwoven ± inflated cylindric hyphae.

Pileipellis a palisadoderm of hyaline to pale yellowish clavate-pedicellate to pyriform cells up to 20 x 9-10 µm, lacking pileocystidia. *Clamp connections* present.

Key to Species of *Agrocybe sororia* complex

1. Pleurocystidia rare or absent .... *A. hortense*
1. Pleurocystidia prominent and frequent.............. 2
    2. Pilocystidia present......................... 3
    2. Pilocystidia absent 4
3. Spores mostly ovoid, 8.5-10.5(-12) µm long......... *A. farinacea*
3. Spores ellipsoid, 10-13.5(-15.5) µm long........... *A. putaminum*
    4. Spores 11-13 x 7-8 µm .... *A. smithii*
    4. Spores 8-11 x 5-7 µm 5
5. Taste farinaceous; pleurocystidia 12-20 µm broad; pileus 5-10 cm broad; in grass .... *A. sororia*
5. Taste bitter at first; pleurocystidia 10-12 µm broad; pileus 3-4 cm broad; on manure .... *A. amara*

AGROCYBE OCCIDENTALIS Watling & Bigelow, sp. nov.
Plate 1, Figs. F, K.

Pileus usque ad 40 mm latus, convexus ad planus, atromelleus, hygrophanus, margo demum cremeus tum luteotinctus, discus ultimus aurantiacus, striatus. Stipes usque ad 50 mm longus, usque ad 5 mm latus, fragiles, albus tum pallide-bubalinus vel pileus subconcolorus. Lamellae adnatae, confertae, angustae tum sublatae, cinnamomeae. Velum hymeniale fugax, albidum. Odore aromaticus. Sporae 7-7.5(-8.5) x 3.5-5 µm, ellipsoidae, truncatae, parietes incrassatae, leves. Cheilocystidia lageniformia, (22-)25-35(-40) x 9-15 µm, apices 1.5-5 µm. Pleurocystidia raro, saccata, 23-29 x 15-17 µm. Cuticularis cellulosus pileus pyriformis, hyphae infra cylindricae et encrustatae. Hyphae fibulatae.

Holotypus: United States, Massachusetts, Hampshire Co., Amherst, near Hasbrouck Laboratory, University of Massachusetts, 21 April 1969. H. E. Bigelow, n. 15625 (MASS).

Pileus up to 40 mm broad, broadly convex to plane, dark butterscotch color fading to cream color, finally pale orange yellow, fading orange at center, hygrophanous, finely striate. *Stipe* up to 50 mm long, 5 mm thick, fragile, white at first then pale buff or concolorous with, but paler than pileus, stuffed then hollow. *Gills* adnate, with short tooth in some basidiomes, close, narrow to medium broad, "Clay Color". *Veil* fugaceous, leaving an annular zone near stipe apex, whitish. *Odor* spicy.

Basidiospores 7-7.5(-8.5) x 3.5-5 μm, ellipsoid in face view, truncate, dingy yellowish in 3% KOH, thick walled, smooth. *Basidia* 4-spored, 20-23 x 5.5-8 μm. *Cheilocystidia* (22-)25-35(-40) x 9-15 μm, lageniform with apex 1.5-5 μm, thin walled, smooth. *Pleurocystidia* rare, scattered, saccate, 23-29 x 15-17 μm. *Hymenophoral trama* of parallel to slightly undulate hyphae mostly shortened and slightly inflated, 4-20 μm broad. *Pileipellis* of rounded pyriform cells intermixed with more elongate or broadly subcylindric hyphae, seated on cylindric hyphae with spiral bands of pigmentation. *Clamp connections* present.

Cespitose on wood-chip mulch under Ohio buckeye *(Aesculus ohiensis)*.

This resembles *A. cubensis* (Murrill) Singer (sect. Pediadae) by the presence of a fugaceous annulus, but differs, however, in size of basidiospores and general facies. Indeed, by its spore character, *A. occidentalis* could be sought in sect. Microsporae, but members of the latter section with which it could be confused possess conspicuous pleurocystidia and large basidiospores. Rare pleurocystidia are found sometimes in members of sect. Pediadae, e.g., *A. pediades* (Pers. ex Fr.) Fayod, and *A. occidentalis* would appear to belong to that section, adding a further dimension to the character used for delimitation.

BOLBITIUS

Bolbitius coprophilus (Peck) Hongo, Mem. Fac. Lib. Arts, Educ. Shiga Univ. Nat. Sci. 9: 82. 1959.
Massachusetts, Hampshire Co., Amherst, near Clark Hall, University of Massachusetts, 10 June 1966. Bigelow 14675. On newly seeded lawn with wood chip cover.

Apparently seldom recorded although probably widespread in North America; recorded from Europe and SE Asia.

CONOCYBE SG. CONOCYBE

Conocybe fragilis (Peck) Singer, Acta Bot. Inst. Komarov Acad. URSS, Series 2, 6: 638. 1950.
Massachusetts, Franklin Co., Shutesbury, 9 July 1958. Bigelow 6757, 6758. Scattered on an abandoned road through conifer woods.

A distinctive species with brightly colored pileus. It has been described from Europe as *Galera incarnata* J. Schaeffer and, although not common, is apparently widely distributed. The absence of lecythiform caulocystidia places this species in sect. Pilosellae.

Conocybe fuscimarginata (Murrill) Singer, Beih. Nova Hedwigia 29: 210. 1969.
Massachusetts, Hampshire Co., Amherst, Clark Hall greenhouse, University of Massachusetts. 27 December 1957. Bigelow 6375; same locality, 30 December 1957. Bigelow 6376; same locality, 8 January 1958. Bigelow 6377; same locality, 18 January 1958. Bigelow 6382. Gregarious in manured plant bed.

This species was originally described from Florida. We can agree with Singer in that it is apparently the same as the collections described by Kühner (1935) as '*C. rickenii* f. *tetraspora*' and identified as such by European authors (e.g. Moser, 1978) in several national herbaria (e.g. Kew, Edinburgh, Lyon, Copenhagen). *Conocybe fuscimarginata* is widespread in Europe and has been recorded from Greenland. The species is a member of sect. Pilosellae.

Conocybe kuehneriana Singer, Beih. Nova Hedwigia 29: 212. 1969.
Massachusetts, Hampshire Co., North Amherst, 30 May 1958. Bigelow 6431; same locality, 11 June 1958. Bigelow 6519. Gregarious in lawn.

This is a member of a complex described under '*Conocybe ocracea*' by Kühner (1935). Only recently (Watling and Gregory, 1981) have the nomenclatural problems involved been unravelled. *Conocybe kuehneriana* refers to the large-spored (10-)10.5-12.5 x (6-)7-7.5(-8) µm) taxon with campanulate pileus (10-25 mm) separated by Kühner as 'recoltes macrospores'.

Conocybe pubescens (Gillet) Kühner, Le Genera Galera, p. 85. 1935.
Massachusetts, Franklin Co., Leverett, 13 October 1959. Bigelow 8747. Scattered on dung in pasture.

This is the true *C. pubescens* with very large spores; it has been confused with *C. subpubescens*; indeed Kühner himself confused the taxon when he transferred *Galera pubescens* to *Conocybe* (1935); this was later rectified (see below). Undoubtedly the species has a world-wide distribution.

Conocybe subpubescens P.D. Orton, Trans. Brit. Mycol. Soc. 43: 195. 1960.
Massachusetts, Hampshire Co., Amherst, Clark Hall greenhouse, University of Massachusetts, 11 February 1961. Bigelow 9414; same locality, 24 April 1961. Bigelow 9415. On fertilized soil in flats in greenhouse.

This is *C. pubescens* (Gillet) Kühner ss. Kühner, 1935 non Gillet, 1876; the validation of *C. subpubescens* (Kühner, Le Botaniste 34: 275. 1949. nomen nudum) by P.D. Orton (1960) is based on a collection different from Kühner's type, but through the kindness of Prof. Kühner one of us (RW) has had access to his collections of species of *Conocybe* and *C. pubescens* ss. Kühner, 1935, has been found to be identical with *C. subpubescens* ss. Orton. The two interpretations undoubtedly refer to the same fungus. Experimentally, the group including *C. pubescens* ss. Gillet and *C. subpubescens* ss. Orton is complex and several entities are known to be present. Some of these entities are morphologically distinct enough to be, and have been, given specific epithets. Caution should be applied therefore in synonymizing all the names in the literature for members of this group after only a superficial examination of the data.

Conocybe subpubescens grows on dung-soil mixtures (rarely directly on dung), on soil, dead grass leaves and accumulations of leaves of deciduous trees and shrubs in moist areas where they have been enriched by worm-casts and insect droppings. *Conocybe subpubescens* is to be found in wood and at edges of woods whereas the closely related *C. pseudopilosella* Kühner and Watling, is found in more open plant communities. *Conocybe pubescens* grows directly on dung and in the British Isles is particularly common on horse droppings.

Conocybe sp.

Plate 3, Figs. A-E.

Pileus 20-60 mm broad, conic, "ochraceous buff" fading to warm buff, disc slightly darker, sometimes rugose to venose in large specimens, glabrous and dull when moist, micaceous when faded, margin rugulose to striate or subsulcate. *Stipe* 50-140 mm x 5-9 mm, bulbous (10-14 mm) tapering gradually upward to apex (2-4 mm), often curved and flexuous, whitish or tinged pale light buff, fibrous striate, silky shining at times, hollow with solid bulb. *Gills* slightly adnexed or free, close to stipe, narrow (1-2.5 mm), close, pallid at first, becoming brown, almost 'ochraceous tawny', margin fimbriate. *Flesh* very thin, concolorous with pileus; taste and odor not distinctive.

Basidiospores 12.5-15 x 8.5-10 µm, ovoid, truncate to distinct germ pore, smooth, thick walled. *Basidia* 4-spored. *Cheilocystidia* 7.5-10 x 12-19 µm, lecythiform, with neck 1.5-2 x 1.5-3.5 µm and head 3.3-5 µm diam, thin walled, soon collapsed. *Pleurocystidia* apparently absent, replaced by brachycystidia 16.5-25 µm broad. *Pileipellis* a palisadoderm of hyaline, or brownish pyriform cells, 25-48 x 7-20 µm, surmounted by a thin gelatinous layer 6-7.5 µm thick; no dermatocystidia present. *Stipitipellis* of hyaline, cylindric hyphae sparsely covered in groups of lageniform to cylindric or broadly ellipsoid cells, 20-40 x 8.5-12.5 µm or 6-8.5 µm broad.

Gregarious or cespitose on manure. United States, Massachusetts, Franklin Co., Leyden, Fizzell Hill Road, 14 August 1959, H. E. Bigelow 8075 (MASS).

In order to place this species precisely, more material is required, but the description is offered to promote discussion and hopefully the discovery of other collections. The species should be recognizable in the field by the large size in conjunction with the buff pileus and glabrous white to buff-tinged stipe.

The collection is placed tentatively in *Conocybe* because of the presence of lecythiform cystidia, general stature and absence of viscidity on the pileus. On the other hand, the collection also seems close to *Bolbitius* by the presence of brachycystidia, large thick-walled basidiospores, a slightly gelatinized pellicle, and vacuolar pigmentation in some cells of the pileipellis. A comparison might be made to *Bolbitius coprophilus* (Peck) Hongo, but Bigelow n. 8075 lacks the distinct salmon, peach or pink tinges to the pileus. With other Conocybes, Bigelow n. 8075 is near the *C. lactea* group of section *Candidae* by its brachybasidia, large spores, a gelatinized pileipellis in age, stature, and pileus color. These characters are also in keeping with *C. elegans* Watling of section Pilosellae.

CONOCYBE SG. PHOLIOTINA

Members of subgenus Pholiotina continue to perplex the agaric investigator, primarily because all collections found, 'come what may', are forced into a described taxon. Undoubtedly this is partly because the full range of species classified in the Friesian traditional genera, and assignable to members of the Bolbitiaceae, has not been fully appreciated. Species assignable to Pholiotina may be found in '*Pholiota*', '*Galera*' and '*Naucoria*' and undoubtedly there is every likelihood that hidden in the literature there will be old names available for more recently found taxa; this does not, however, appear to be the case for the species described below.

CONOCYBE MARGINATA Watling & Bigelow, sp. nov.
Plate 3, Figs. F, G; Plate 5.

Pileus (8-)15-40 mm latus, primum obtuso-convexus, dein convexus late convexus, tandem subplanus, in vetustae interdum subumbonatus, senatus ad badius, hygrophanus, demum pallido-luteus, glaber, viscidus, margines cum velum fragmenti. Stipes 20-85 mm longus, 2-7 mm latus, pallido-bubalinus. Lamellae adnatae, confertae, latae (3-7 mm), primum sordido-stramineae, demum fulvus. Velum albidum; pileus ad marginem appendiculatus.

Sporae 9.5-10.5 x 5.5 µm, ellipsoidae, parietes incrassatae, leves. Cheilocystidia cylindrica et flexuosa vel ± lageniformia, 22.5-30 x 4.5-6 µm, apices obtusi vel subcapitati, leves vel crystallini, 3.0-4.5 µm latae; pleurocystidia nulla. Hyphae fibulatae. Cuticularis cellulosus, gelatinosus, sphaeropedunculatus, 12-15 x 30-45 µm.

Holotypus: United States, Massachusetts, Franklin Co., Conway, Baptist Hill, 30 May 1968. H. E. Bigelow 12546 (MASS).

Pileus (8-)15-40 mm broad, obtuse convex when young becoming convex to broadly convex, finally subplane, broadly subumbonate at times toward centre in age, rather dark 'Sanford's brown' to 'Amber brown' fading to light orange yellow, tinged tawny at disc for some time, glabrous, viscid when fresh, hygrophanous; margin repand and undulate in age, nonstriate, with appendiculate triangular patches of veil. *Stipe* 20-85 x 2-7 mm, equally or slightly enlarged at base, often curved, brittle cartilaginous, pale dingy buff with thin, whitish fibrillose, soon appressed covering at first, then longitudinally fibrillose striate, white tomentose in soil, hollow. *Gills* adnate, seceding, close, broad (3-7 mm), dingy yellowish at first then near 'Buckthorn brown' when mature; edge white fibrillose. *Veil* whitish adhering to pileus margin as skirt, finally appressed.

Basidiospores 9.5-10.5 x 5.5 µm, rather narrowly elliptic in face view, in profile slightly flattened on one side, thick walled, sienna colored in water, relatively dark sienna in 3% KOH, germ pore prominent and central, apiculus distinct. *Basidia* 4-spored, clavate pedicellate, relatively broad with four short distinct sterigmata, 21.5-25 x 7.5-9 µm, hyaline. *Cheilocystidia* cylindric flexuous with slightly swollen base to irregularly lageniform with obtuse, sometimes subcapitate apex, 22.5-30 x 4.5-6 µm, apex 3.0-4.5 µm, neck 3.8-5.5 µm broad, apex of some frequently covered with irregular amorphous or crystalline material; pleurocystidia absent. *Pileipellis* a very orderly palisadoderm of gelatinized, spheropedunculate cells with long distinct pedicel, 12-15 x 30-45 µm, pedicel base usually sienna colored, 3.5-4.5 µm broad; *pileocystidia* lacking. *Stipitipellis* of hyaline, cylindric hyphae covered with loose covering of hyaline, anastomosing cells; *caulocystidia* found only at apex of stipe. *Hymenophoral trama* compact, of regularly arranged, broad, shortened cells, with little differentiation between medio- and lateral strata. *Clamp connections* present.

Gregarious to subcaespitose. On manure-enriched soil under barn.

This species is characterized by the large size, reduced veil, rather variable (cylindric-flexuous to lageniform) cheilocystidia and constantly medium-sized, narrowly ellipsoid basidiospores. It differs from *C. exannulata* Kühner ex Watling and *C. vestita* (Fr. in Quélet) Kühner in

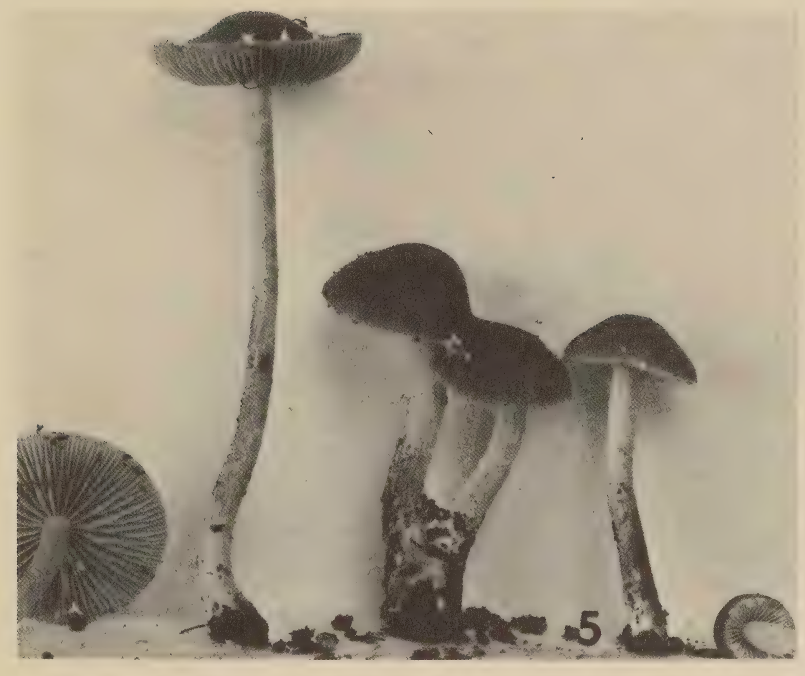

Plate 5. *Conocybe marginata* X 1.

the presence of a well-defined germ pore and from *C. mutabilis* Watling ined. (= *C. togularis* f. *exannulata* recolte macrospore: Kühner, 1935) in the morphology of the cheilocystidia. From *C. appendiculata* Lge. & Kühner ex Watling and *C. dentatomarginata* Watling, *C. marginata* differs in color and size of pileus and morphology of both cheilocystidia and basidiospores.

Conocybe appendiculata J. E. Lange and Kühner ex
Watling, Persoonia 6: 329. 1971.

Massachusetts, Franklin Co., Sunderland, Mt. Toby, 4 October 1958. Bigelow 7905. On soil in the open.

The appendiculate veil, ellipsoid basidiospores, 7-8 x 4-5.5 µm, each with a small germ pore, and irregularly cylindric lageniform cheilocystidia characterize this taxon. Recently Watling (1980) separated Kühner's *C. appendiculata* f. *macrospora* (1935) as a distinct taxon, *C. dentatomarginata* Watling, with thick-walled, relatively large ellipsoid basidiospores (10-11.5 x 5-6 μm) and sicyoid to lageniform cheilocystidia with narrow necks. *Conocybe appendiculata* was described from specimens collected near Paris, France, and the species is known to occur in the British Isles, Denmark, The Netherlands, and Russia. *Conocybe dentatomarginata* is known only from France and the British Isles.

Conocybe filaris (Fries) Kühner, Le Genera *Galera*, p. 159. 1935.
Massachusetts, Hampshire Co., Amherst, Clark Hall greenhouse, University of Massachusetts. 18 January 1958. Bigelow 6379; same locality, 2 February 1958. Bigelow 6384. Singly, on soil in plant pots in greenhouse.

There has been some confusion between this and the North American *C. rugosa* (Peck) Watling (van Waveren, 1970). Although close, *C. rugosa* (= *Pholiotina*) can be separated by the generally larger size of the basidiomes, strongly rugose pileus disc, slightly larger basidiospores and acute cheilocystidia. Both species are recorded from the United States, indeed Brady et al. (1975) have shown North American material of *C. filaris* to contain an amatoxin.

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The authors are indebted to Prof. T. Hongo, Shiga University, Tokyo for his gift to E of isotype material of *Agrocybe farinacea* and to Dr. C. Bas, Leiden for his loan of material of *A. putaminum*. Dr. D. Pfister kindly loaned the type collection of *A. hortense* deposited at the Farlow Herbarium, Harvard University, Cambridge. We also greatly appreciate Dr. A. H. Smith's kindness in reviewing the manuscript.

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Taxonomic and Nomenclatural Notes on Boletes

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I. A Nomenclatural Note on *Ixechinus* (Boletaceae)

ABSTRACT

The nomenclature of *Ixechinus* and its included species, *I. majus* Heim ex Horak and *I. minus* Heim ex Horak, is reviewed. Correct nomenclatural citations of species are presented.

Wolfe (1981) summarized the nomenclatural history of the tribe Ixechineae Heim ex Wolfe, typified by *Ixechinus* Heim ex Horak. Since that publication the apparent valid publication of the species of *Ixechinus* has come into question. The purpose of this paper is to clarify the nomenclature of the genus and its included species.

When originally published *Ixechinus majus* Heim and *Ixechinus minus* Heim were invalid since the genus name itself was not validly described by Heim (1939). Wolfe (1982) indicated that there might be a problem concerning the typification of *Ixechinus majus* and consequently the genus itself. Further investigations into this problem have shown that *I. majus* Heim ex Horak was described in Latin, and at the end of the protologue information leading to the identification of a Heim collection of *I. majus* was given. A study of that specimen has been presented (Wolfe, 1982), and that specimen is an explicit holotype. There can be no other holotype as was alluded to earlier by Wolfe (1982). Horak (1968) also mentioned and described the holotype of *I. minus*. Furthermore, he gave an indirect reference to Heim's (1939) earlier publication of *I. minus* thereby validly publishing the name (ICBN Art. 32.1; Stafleu, et al., 1978):

The following should be considered the correct citations of the genus and species names with nomenclatural synonyms.

Ixechinus Heim ex Horak. 1968. Beiträge zur Kryptogamenflora der Schweiz. Vol. XIII. Die Gattungstypen Der Agaricales, p. 668.

Ixechinus majus Heim ex Horak. 1968. Beiträge zur Kryptogamenflora der Schweiz. Vol. XIII. Die Gattungstypen Der Agaricales, p.668.
[≡ *Fistulinella major* (Heim ex Horak) Guzmán. 1974. Bol. Soc. Mex. Mic. 8: 59. nom. inval., per Art. 33.2]

Ixechinus minus Heim ex Horak. 1968. Beiträge zur Kryptogamenflora Der Schweiz. Vol. XIII. Die Gattungstypen Der Agaricales, p. 669.
[≡ *Fistulinella minor* (Heim ex Horak) Guzmán. 1974. Bol. Soc. Mex. Mic. 8: 59. nom. inval., per Art. 33.2]

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The author would like to extend his grateful appreciation to Dr. Ronald H. Petersen and Dr. Richard P. Korf for their generous assistance with the solution of this nomenclatural problem.

II. A New Species of *Tylopilus* (Boletaceae)

ABSTRACT

A new bolete species, *Tylopilus snellii*, is described from New Jersey. The taxon belongs to the subgenus *Porphyrellus* and is allied with *T. nebulosus* and *T. fumosipes* on the basis of cystidial similarities.

During the 1982 annual foray of the North American Mycological Association a small, gray bolete was collected by Kenneth and Charlotte Franklin and subsequently brought to my attention by Nancy Smith Weber. The combination of macroscopic characteristics suggested that it was a species of *Tylopilus* subgenus *Porphyrellus*, a group of boletes with which I have been working for some time.

On the basis of field and microscopic characteristics this collection was found to be significantly different from other North American and world taxa of the subgenus. This taxon, therefore, deserves specific rank recognition, and the following new species is proposed.

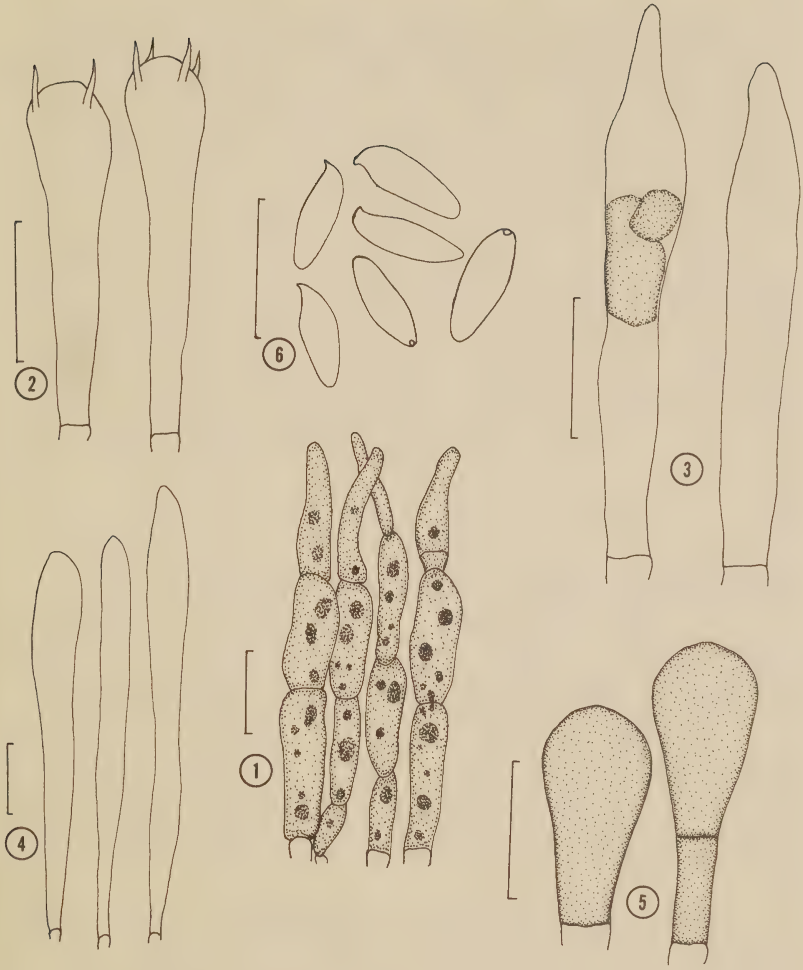
Tylopilus snellii, sp. nov.

Pilei superficies glabra, sicca, colore immutato nocito; contextum subcremeum transeuns ad caeruleum nocitum transeuns ad rufobrunneum et denique fuscum. Tubi et pori albi transeuntes ad haematinas ad vinaceos nocitos et denique fuscos. Stipes albolutescens ad cremeum transeuns ad brunneum ubi tactus; contextum subcremeum transeuns ad caeruleum nocitum transeuns rufrobrunneum et denique fuscum. Pleurocystidia, cheilocystidia, et caulocystidia praesentia; pseudocystidia absentia. Holotypus ex Princeton Camp prope Blairstown, Warren County, New Jersey; in Herbarium Penn. St. Univ.(PAC); 20.viii.1982, C. B. Wolfe 1376.

Etymology. - - This new bolete species is named in honor of Walter H. Snell and Esther Dick Snell who have contributed so much to our knowledge of the North American boletes.

Pileus 3.0 x 1.0 cm, convex, without sterile margin; surface smooth, pruinose, dry, unchanging on injury; "dark blonde" to "clay" (Methuen 5/D,E/4,5) over disc fading to "nutria", "sepia(brown)" (Methuen 5/F/3,4) near margins; context 0.5 cm thick over stipe, pallid cream initially becoming faint blue-green then red-brown to sordid brown on injury. Tubes 3-4 mm long when immature, adnate to adnexed, white instantly becoming blood-red to vinaceous red on injury changing to red-brown and finally sordid brown. Stipe 5.0 x 1.0 cm, obclavate, faintly pruinose, "yellowish white" to "cream" (Methuen 4/A/2,3) becoming sordid brown on handling; context white to pallid cream becoming blue-green in upper half on injury then vinaceous red to blood-red and finally sordid brown. Basidiospore color in deposit unknown.

Pileus cuticle a palisade trichodermium (Fig. 1); terminal cells 5.0-10.5 µm diam. (d^m = 7.0 µm), hyaline to pallid cream in KOH, yellow in Melzer's reagent, dark blue in cotton blue, equal to tapering distally, subterminal cells inflated, some contents oily; hypodermial cells dextrinoid in Melzer's reagent. Hyphae of tube trama 4.0-11.5



Figures 1-6. *Tylopilus snellii*. 1. Trichodermium. 2. Basidia. 3. Pleurocystidia. 4. Cheilocystidia. 5. Caulocystidia. 6. Basidiospores. Standard line = 20 μm.

µm diam. (d^m = 8.0 µm), boletoid in arrangement, hyaline in KOH, hyaline yellow in Melzer's reagent, hyaline to dark blue in cotton blue; walls appearing irregularly thickened in KOH and Melzer's presumably from a gelatinization or disintegration of the hyphal walls. Gloeoplerous hyphae 2.5-9.0 µm diam. (d^m = 5.0 µm), gold in KOH, gold in Melzer's reagent, dark blue-green in cotton blue, contents homogeneous to granular. Clamp connections absent.

Basidia (Fig. 2) 40.5-58.5 x 11.5-13.5 µm (D^m = 53.5 x 13.0 µm), clavate, 4-sterigmate, hyaline in KOH, yellow to pale yellow with faint pink tones in Melzer's reagent, pale blue to dark blue in cotton blue. Pleurocystidia (Fig. 3) 57.0-88.5 (-103.5) x 9.0-13.0 µm (D^m = 71.5 x 11.5 µm), fusoid-ventricose to narrowly fusoid-ventricose, occasionally broadly lanceolate, hyaline to pale yellow to gold in KOH, yellow-gold to gold-brown to rust-brown (subdextrinoid) in Melzer's reagent, hyaline to dark blue-green in cotton blue; contents coagulating in all reagents. Pseudocystidia absent. Cheilocystidia (Fig. 4) 82.0-130.0 x 13.0-21.0 µm (D^m = 106.5 x 14.5 µm), narrowly clavate, hyaline in KOH, yellow hyaline in Melzer's reagent, hyaline in cotton blue, occasionally secondarily septate. Caulocystidia (Fig. 5) 30.0-74.0 x 9.0-15.5 µm (D^m = 36.5 x 11.5 µm), clavate to equal, hyaline to pallid in KOH, yellow hyaline in Melzer's reagent, hyaline to pale blue in cotton blue; caulobasidia occasionally present, dimensions same as caulocystidia.

Basidiospores (Fig. 6) 13.0-18.0 x 5.0-6.0 µm (D^m = 15.5 x 5.0 µm; E = 2.5-3.5; E^m = 3.0), inequillateral in profile, elliptical in face view, cream-tan to pale cinnamon in KOH, subsextrinoid (cinnamon-rust) in Melzer's reagent, pale cinnamon in cotton blue; surface smooth, walls continuous, without germ pore.

Habitat and Distribution. *Tylopilus snellii* is known only from a single location in Princeton Camp near Blairstown, New Jersey (USA). It was found in humus and leaf litter under *Carya* sp., *Pinus* sp., and mixed hardwoods.

Observations. *Tylopilus snellii* keys out to *T. nebulosus* (Wolfe, 1979) based on the hymenium color change on injury and the subdextrinoid, coagulating contents in pleurocystidia. Macroscopically *T. snellii* has a gray-brown pileus with a cream colored stipe which changes to brown on handling. The pileus and stipe of *T. nebulosus* are brown to sooty brown, colors quite different from those of *T. snellii*. The cheilocystidia of *T. snellii* are much larger

(D^m = 106.5 x 14.5 μm) with thinner walls than those of *T. nebulosus* (D^m = 71.5 x 10 μm). Spore dimensions of these two taxa are quite similar; however, those of *T. snellii* are more slender (E^m = 3.0) than those of *T. nebulosus* (E^m = 2.4). As more specimens of *T. snellii* are found and studied quantitatively the range of dimensions of some characters may change. Pseudocystidia are absent in both these taxa. *T. snellii* is classified alongside *T. nebulosus* and *T. fumosipes* by virtue of the presence of similar pleurocystidia, cheilocystidia, caulocystidia, and gloeoplerous hyphae. In terms of overall distribution patterns *T. nebulosus* appears to be restricted to the northeastern quadrant of North America and also in Yorkshire in England. *T. fumosipes* is widely distributed in the eastern half of North America. However, *T. snellii* at present is known only from the type locality in northwestern New Jersey near The Delaware Water Gap National Recreation Area.

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MYCOTAXON

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NEW OR INTERESTING MICROFUNGI

VIII. CORYNESPOROPSIS INDICA SP.NOV.

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Corynesporopsis indica P.M. Kirk, sp.nov. (Figs 1-2)

Coloniae pilosae, fuscae ad atrae. Mycelium partim superficiale sed in substrato plerumque immersum, ex hyphis laevibus, ramosis, septatis, pallide brunneis ad brunneis, 1·5–2·5 µm latis compositum. Conidiophora macronematosa, mononematosa, erecta, solitaria vel fasciculata terna vel quaterna, simplicia, recta, laevia, brunnea, septata, 50–160 µm alta, 3–5 µm lata, ad fundamentum interdum inflata usque ad 12 µm lata. Cellulae conidiogenae in conidiophoris incorporatae, monotreticae, terminales, percurrentes. Conidia acrogena, solitaria vel in catenis simplicibus bina vel terna, catenis facile fractis, sicca, laevia, atrobrunnea ad atrobrunnissima, in medio 1-septata, septo ob atroligamentum plerumque obscuro, ellipsoidea ad late obovoidea, interdum aspectu biconica, (14–) 17–24 (–27) µm longa, 8–12 (–14) µm lata.

In ramunculo emortuo *Sterculiae* sp., Kanakeshwar, Alibad, Maharashtra, India, July 1978, C.H. Phadke AMH 4217, IMI 239942, holotypus.

Colonies hairy, blackish-brown to black. *Mycelium* partly superficial but mostly immersed in the substratum, composed of smooth, branched, septate, pale brown to brown, 1·5–2·5 µm wide hyphae. *Conidiophores* macronematous, mononematous, erect, solitary or fasciculate in groups of 3 or 4, simple, straight, smooth, brown, septate, 50–160 µm high, 3–5 µm wide, sometimes swollen at the base up to 12 µm wide. *Conidiogenous cells* integrated, monotretic, terminal, percurrent. *Conidia* acrogenous, solitary or in simple chains of 2 or 3, chains readily fragmenting, dry, smooth, dark brown to very dark brown, medianly 1-septate, the septum usually obscured by a dark band, ellipsoid to broadly obovoid, sometimes somewhat biconic, (14–) 17–24 (–27) µm long, 8–12 (–14) µm wide.

Specimen examined: On dead twig of *Sterculia* sp., Kanakeshwar, Alibad, Maharashtra, India, July 1978, C.H. Phadke AMH 4217, IMI 239942, holotype.

In certain respects *Corynesporopsis indica* resembles *Hemicorynespora mitrata* (Penz. & Sacc.) M.B. Ellis and *H. deightonii* M.B. Ellis (Ellis, 1972). The morphology of the base of the conidium, which appears distinctly flattened under the light microscope and possesses a central pore, is remarkably similar in the three species and it is likely that conidiogenesis is identical also. In *Hemicorynespora*, however, conidia are solitary and, perhaps as a direct result of this, proliferation of the conidiogenous

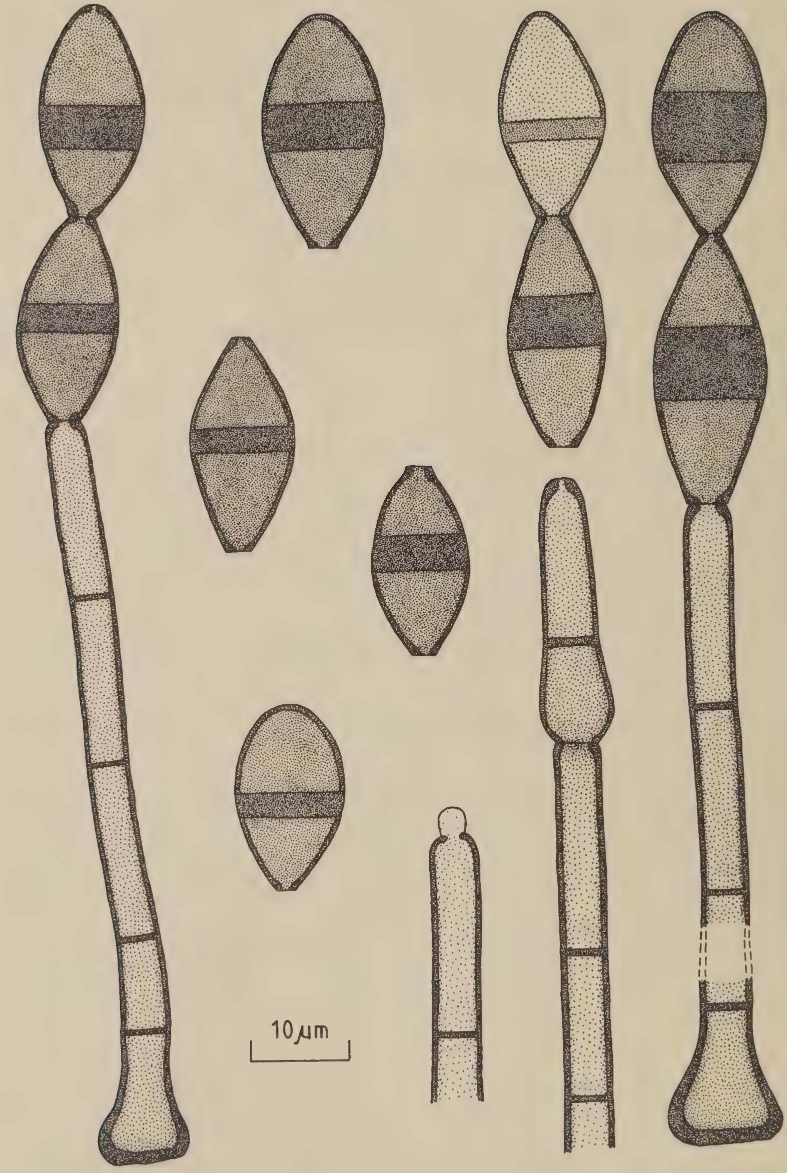

Fig. 1. *Corynesporopsis indica.*

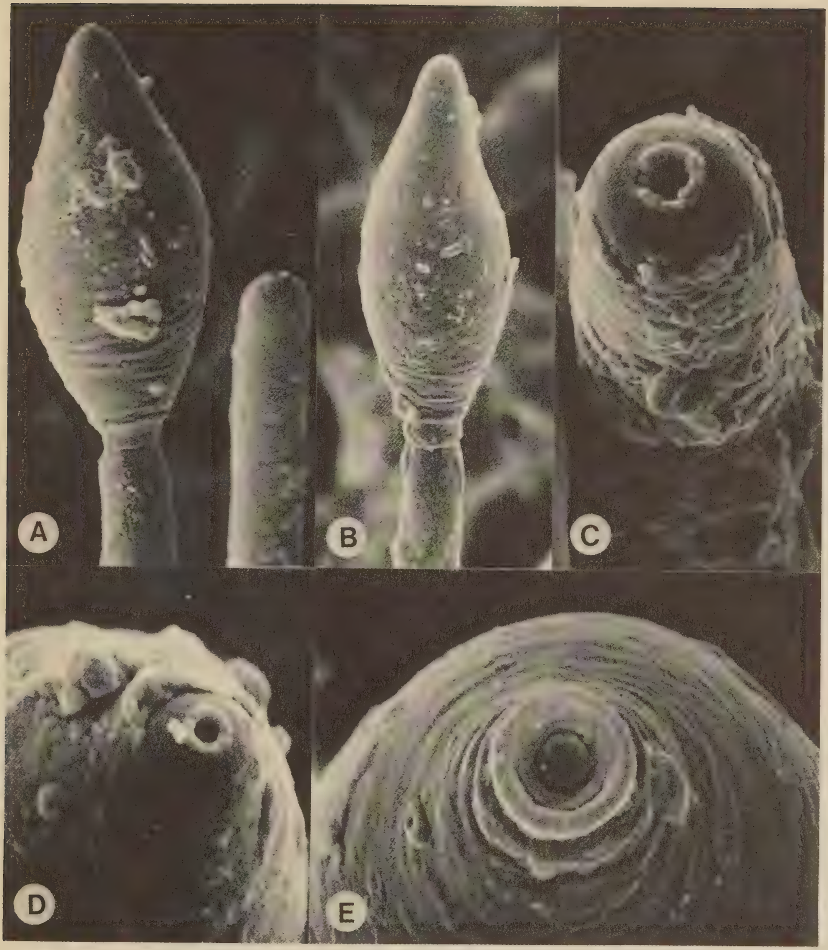

Fig. 2. *Corynesporopsis indica.* A-B. Mature conidia attached to the conidiophore (x 3000). C. Conidiogenous locus at apex of conidiophore (x 9000). D. Conidiogenous locus at apex of conidium (x 8500). E. Base of conidium (x 8500).

cell appears to be more frequent. The present species differs from other species of *Corynesporopsis* (Kirk, 1981a, 1981b) in conidium morphology.

The results obtained when *C. indica* was examined with the scanning electron microscope (Fig. 2) are, perhaps, worthy of further comment. The base of the conidium appears abruptly truncated when viewed laterally and when still attached to the conidiogenous cell (Figs 2A-B) the possession of a flat base is suggested. However, the apex of the conidiogenous cell is convex (Fig. 2C) and the base of the seceeded conidium is, in contrast, concave (Fig. 2E). The appearance of the conidiogenous locus appears to be identical whether it occurs at the apex of the conidiogenous cell (Fig. 2C) or, in catenate conidia, at the apex of the conidium (Fig. 2D). It comprises a central pore bounded by a ring-like zone with a somewhat irregular surface and a wider, relatively smooth area. The smooth area would appear to correspond to the area occupied by the base of the conidium but the relationship of the ring-like zone is not readily apparent. It is evident that further studies employing transmission electron microscopy will be required before a true understanding of the conidiogenesis in *C. indica* can be reached.

The author is indebted to Dr D.W. Minter for correcting the Latin diagnosis and to Dr B.C. Sutton for critically reading the manuscript.

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MYCOTAXON

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MYCELIAL CHARACTERS, ANAMORPHS, AND TELEOMORPHS IN GENERA AND SPECIES OF VARIOUS FAMILIES OF AGARICALES IN CULTURE

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ABSTRACT

Cultures of eighteen species in various genera and families of Agaricales were studied. Macroscopic and microscopic features of their mycelial characters, presence of anamorphs, and development of teleomorphs in some species are given.

INTRODUCTION

Extensive cultural work with higher Basidiomycetes, mainly Agaricales, has been conducted in our laboratory for several years.

The stimulus for starting this line of research in the Athens laboratory was, on the one hand, the writings by Watling (1979) and Kendrick and Watling (1979), who emphasized the importance of obtaining more information on anamorphs in Agaricales, and the other, the aim to improve the taxonomy of genera and species difficult to classify because of the variability of their teleomorphs in nature. The authors emphasize the meagre knowledge of the basidiomycetous anamorphs and the need for further research. The long experience of the senior author with culturing members of the Boletaceae (Pantidou 1961a, b, 1962, 1964; Pantidou & Groves 1967; Pantidou & Watling 1970, 1973) provided sufficient experience to handle this line of research.

The anamorphs reported in this work belong generally to the categories already known for other genera and species of the Hymenomycetes, i.e., arthric conidia, holoblastic conidia, chlamydospores, and sclerotia. From our study no anamorphs were detected on the basidiomes from which the cultures were obtained. It can probably be assumed that the anamorphs in Agaricales do not often occur with the teleomorphs. Possibly the anamorphs develop in the vegetative mycelium which grows in the soil or other substrata and cannot be easily detected. Also the possibility cannot be excluded that the cultural media allow development of the asexual stage better than the soil on which the fungus is normally found. Examination of mycelia at the base of the stipes showed hyphae with clamp-connections in those species with clamps, but never anamorphs. It is believed that every effort should be directed to recording the anamorphs of agarics and any hyphal differentiation observed in their vegetative mycelia in pure culture (Miller, 1971), in a parallel way to that already undertaken by Nobles (1965), Stalpers (1978), etc. for wood-inhabiting Hymenomycetes.

Techniques: Achieving pure cultures of Basidiomycetes is not an easy task at times. A number of species do not grow on the media normally used in the laboratory or grow very slowly. Special attention must be paid to providing a suitable medium (Watling, 1981). It is also difficult to obtain tissue that is not contaminated with either bacteria or yeasts, the latter proving to be the most frequent obstacle to procuring pure cultures. Techniques for isolating and purifying cultures of agarics have been described by Watling (1971a).

Three types of media were used:

1. Hagem's medium as modified by Modess (HgM).
2. Potato dextrose agar (PDA), prepared from raw potatoes.
3. Kauffman's modified malt extract medium (Kf).

PDA proved to be the most favourable for the majority of the species studied whereas, in contrast and surprisingly, HgM was unsatisfactory for all of them. Kf proved favourable for only some species and it was only on this medium that Hebeloma eburneum produced sclerotia.

All cultures were established from basidiomes collected from nature. The tissue used for inoculation was cut from the point of union between pileus and stipe or from the context of the pileus.

Mounts for microscopic examination were made from the margin of the mycelial mat, the centre, and from the aerial and the submerged parts. The most productive study was that utilising young cultures with active growth, although in some instances anamorphs and teleomorphs were found in culture only after several transfers.

The amyloidity of all hyphae was tested with Melzer's reagent; a negative reaction was found in all of the species tested. Spot tests on the mycelial mat using various chemicals used in other authoritative studies (Watling, 1971b), except for gum guaiac, also gave negative reactions. Even with this reagent the blue spot produced (see the descriptions, below) generally was not consistent in its intensity.

Efforts are being made to maintain all the cultures although this was not always successful. Voucher material supporting all cultures are preserved in the Institute Herbarium.

The herbarium specimens are indicated with the symbols ATHU-M, and the culture numbers are preceded by the letter A.

DESCRIPTION OF SPECIES

AGARICACEAE

Agariceae

Agaricus silvicola (Vitt.) Peck

In forest of Pinus halepensis, Ayia Trias-Attiki, 3.II.82, Coll. K. Katrakazou, (ATHU-M 1719), (A-212).

Cultural characters

Macroscopic: Mycelial mat 7 cm in 30 days, white, surface with outgrowths, margin irregular. Reverse chamois. Blue spot with gum guaiac.

Microscopic: Hyphae in long threads, 2.5–5.0 µm in diam. with long branches. Clamp-connections not seen. Many hyphae becoming coiled terminally or intercalarily (Figs. 1, 2). Other hyphae forming characteristic terminal or intercalary rings (Fig. 3).

Remarks: Best growth was obtained on PDA. The coiled hyphae are similar to those in Clitocybe geotropa.

AMANITACEAE

Amanita ovoidea (Bull. ex Fr.) Quél.

In forest of Pinus halepensis, lower Mt. Parnis-Attiki, 13.XI. 79, Coll. E. Kapsanaki - E. Papathanasaki, (ATHU-M 1653), (A-8).

In mixed conifers, Tatoi-Attiki, 27.XI.79, Coll. M. Pantidou, (ATHU-M 1659), (A-32); Tatoi-Attiki, 20.XI.80, Coll. M. Pantidou - Z. Gonou, (ATHU-M 1657), (A-137).

Cultural characters

Macroscopic: Mycelial mat with a slow rate of growth, surface uneven with outgrowths. Reverse buff-hazel.

Microscopic: Simple hyphal system with thin, 2.5–3.5 µm diam., hyaline, non-amyloid hyphae with simple, distant branching. Clamp-connections were not found in any isolate of A. ovoidea.

Remarks: Best growth on PDA.

Amanita pantherina (DC. ex Fr.) Secr.

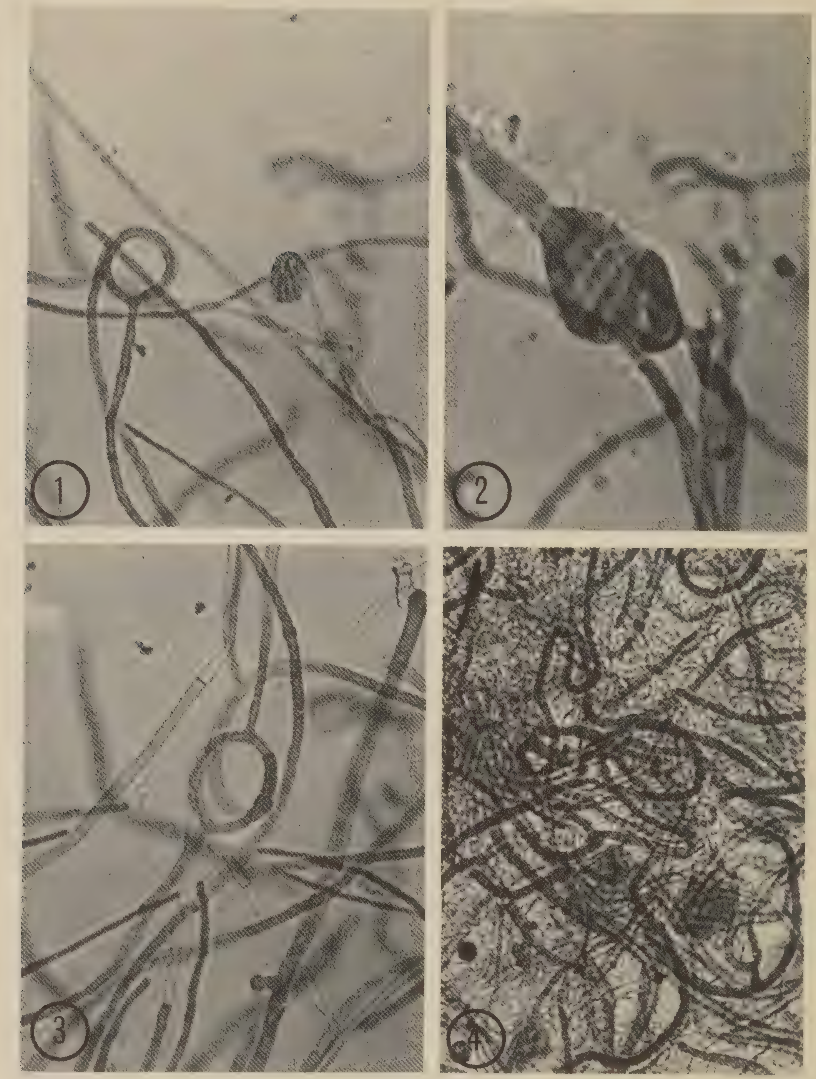
In forest of Abies cephalonica, upper Mt. Parnis-Attiki, 25.XI. 80, Coll. M. Pantidou - Z. Gonou, (ATHU-M 1680), (A-146).

Cultural characters

Macroscopic: Mycelial mat with a slow rate of growth, white, surface uneven with few outgrowths. Reverse buff-hazel.

Microscopic: Simple hyphal system with thin, 2.5–3.5 µm diam, hyaline, non-amyloid hyphae and simple, distant branching. Clamp-connections simple, very rare. In older cultures of this species abundant lactiferous hyphae were present, even predominating (Fig. 4) to the extent of 60% of the microscopic mount.

Remarks: Best growth on PDA.



FIGS. 1-3. **Agaricus silvicola.** 1. Hyphae coiled terminally and with intercalary ring, X 80. 2. Hypha with intercalary coiling, X 160. 3. hypha with intercalary ring, X 80. FIG. 4. Lactiferous hyphae in **Amanita pantherina**, X 80.

COPRINACEAE

Coprinus comatus (Müll. ex Fr.) S.F. Gray
In field, Dionisos-Attiki, 18.XI.80, Coll. K. Katrakazou, (ATHU-M 1716), (A-130).

Cultural characters

Macroscopic: Growth fast on PDA, filling the plate in 30 days. Mycelial mat whitish, thin, very little aerial, separating cleanly from the agar. Reverse hazel.

Microscopic: Hyphae 1.5-5.0 µm diam., some with uneven walls, non-amyloid. Branching irregular, some with long branches, some dendritic, a few lactiferous hyphae present. Strands frequent. Clamp-connections prominent, large, round, mostly as side clamp-connection, more rarely on branches.

Panaeolus sphinctrinus (Fr.) Quél.
In forest of Pinus halepensis, Kiourka-Attiki, 4.IV.82, Coll. K. Katrakazou, (ATHU-M 720), (A-238).

Cultural characters

Macroscopic: Fast growth, filling the plate in 20 days. Mycelial mat white, irregular, cottony. Reverse chamois. A month-old culture developed greyish-brown, loosely structured sclerotia, covered with aerial, white mycelium. Basidiomes developed in groups. Primordia appeared in cultures a few days old and in a week the basidiomes were mature (Fig. 42).

Microscopic: Hyphae homogeneous in long threads, 2.4-3.6 µm diam., with long branches. Abundant clamp-connections, either on main hyphae or on branches or on both. Many hyphal bridges formed.

Sclerotia of loosely arranged, yellow-brown and intricately branched hyphae.

Remarks: A full description of the development and structure of the basidiomes is not given since the same species has already been described by Ola'h (1969). Ola'h obtained mature basidiomes of this species in natural and semi-natural medium but failed to obtain fructification in an entirely synthetic medium. In our isolate no arthrospores were found although arthrospores of this species in culture are reported by Ola'h and by Watling (1979) from personal observations. On the other hand the formation of sclerotia is not mentioned by Ola'h.

CORTINARIACEAE

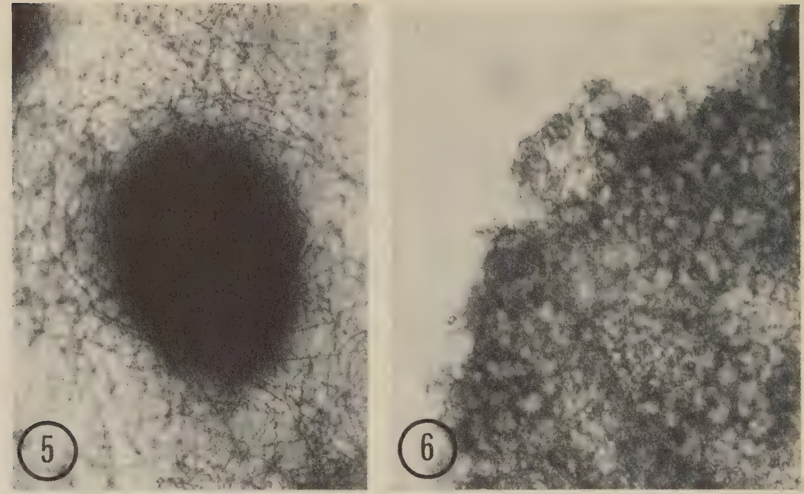
Inocybeae

Hebeloma eburneum Malençon
In forest of Abies cephalonica, Trikala-Korinthia, 2.XII.82, Coll. M. Pantidou - Z. Gonou, (ATHU-M 1697), (A-179).

Cultural characters

Macroscopic: Growth fast, filling the plate in less than 30 days. Mycelial mat pure white, cottony, fluffy, margin even. Reverse pale cream. Gum guaiac on mat turns the spot blue.

Sclerotia formed in 60-day old cultures, dispersed over entire



FIGS. 5-6. **Hebeloma eburneum**. 5. Sclerotium, X 16. 6. Part of section of sclerotium, X 25.6.

mycelial mat, more abundant towards the margin, singly or in groups, covered by the aerial mycelium, at first white, gradually turning chamois and brown when mature, round or ovoid, 1-2 mm (Fig. 5).

Microscopic: Hyphae in long threads, of three sizes: narrow (1-2 µm diam.), medium (2-3 µm diam.), and wide (6-7 µm diam.), non-amyloid, often with abundant crystalline material. Side clamp-connections frequent and clamps on the main hyphae and on the branches at the same level.

In section the sclerotia show a closely packed tissue with no intercellular spaces, and cells round or angular, dark yellow to brown in the center, deeply staining in phloxine and very granular in the outer layer (Fig. 6).

Remarks: Sclerotia were produced on Kf medium and sparsely on HgM.

PAXILLACEAE

Paxillus involutus (Batsch ex Fr.) Fr.

Amongst Populus sp., Kiourka-Attiki, Coll. K. Katrakazou, 30.X.80, (ATHU-M 1687), (A-84).

In forest of Pinus halepensis, Kiourka-Attiki, Coll. K. Katrakazou, 30.XI.81, (ATHU-M 1699), (A-167).

Cultural characters

Macroscopic: Growth rather fast, almost filling the plate in 30 days. Mycelial mat strongly coloured, the aerial part milky-coffee and the appressed part fulvous, drops of yellow-brown fluid formed on the surface, strong discoloration of the medium. Reverse date brown.

Microscopic: Hyphal system very heterogeneous. Some hyphae thin, 1.5-3.0 µm diam., some broad, 7-8 µm diam., all yellow, many papillate, lactiferous hyphae prominent, broad, with yellow-green fluid. Dark yellow, granular hyphae, some with thick walls and large refractive swellings strongly adhering to hyphae (Figs. 7, 8). Strands frequent, with perfectly parallel arrangement and wider central hypha.

All the above types of hyphae have clamp-connections which show configurations as in Fig. 43, although paarige branching with three clamp-connections is rare.

Remarks: It is interesting to note that many hyphae form small fluid swellings on one side of their wall. These gradually enlarge to form a spherical ball (Figs. 9, 10, 11). This apparently is the origin of the fluid drops on the surface of the agar. In its paarige branching and other macroscopic and microscopic features the culture of P. involutus resembles those of many species of Boletaceae.

STROPHARIACEAE

Stropharia aeruginosa (Curt. ex Fr.) Quél.

In forest of Pinus halepensis, Korinthia, 11.XI.79, Coll. A. Mavridis, (ATHU-M 1663), (A-2).

Cultural characters

Macroscopic: Mycelial mat 4 cm in 30 days, the center white with some aerial fluffy mycelium, silky, gradually developing a greenish zone, margin even, thin, white. Reverse also somewhat zonate, cream in the center, a greenish zone and pale in the periphery. Mat cleanly separates from the surface of the agar.

Microscopic: Hyphal system rather homogeneous with long threads, the majority narrow, 1.2-2.0 µm diam., but a few up to 5.0 µm, some of them lactiferous, non-amyloid. Strands with intertwined hyphae. Clamp-connections frequent, prominent, often present with hyphal bridges (Figs. 12, 13, 43).

TRICHOLOMATACEAE

Clitocybeae

Clitocybe geotropa (Bull. ex St. Amans) Quél.

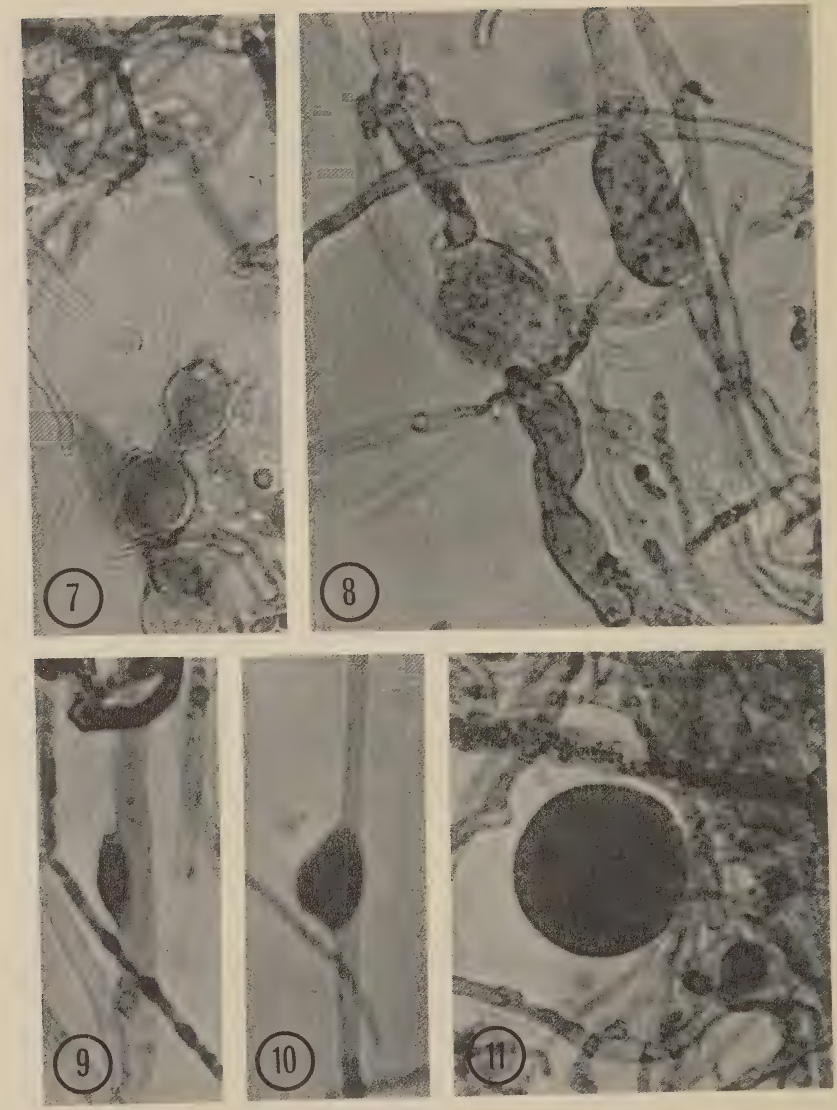
In forest of Abies cephalonica, upper Mt. Parnis-Attiki, 7.XI.80, Coll. M. Pantidou - Z. Gonou, (ATHU-M 1635), (A-91).

In forest of Pinus halepensis, Ayia Trias-Attiki, 13.XII.81, Coll. K. Katrakazou, (ATHU-M 1703), (A-214); Pilion, Coll. Ioannidis, 12.XII.81, (ATHU-M 1702), (A-204).

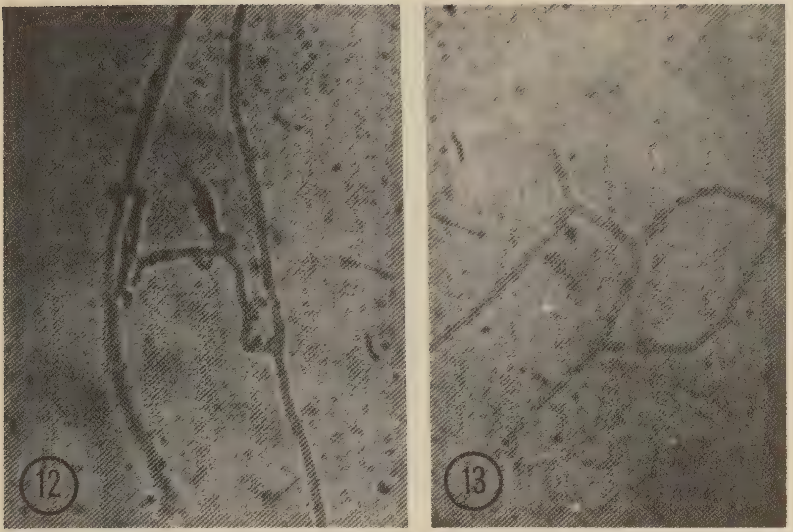
Cultural characters

Macroscopic: Growth fast, filling the plate in 30 days. Mycelial mat snow white, thin, appressed with small raised tufts, cleanly separating from the surface of the agar. Reverse pale cream. In A-204 spot bluing with gum guaiac, but not consistently.

Microscopic: Hyphae in long threads, thin, 1.5-2.5 µm diam., a few 6.0 µm diam., branching distant, with long branches, hyphal bridges frequent, clamp-connections frequent in many and interesting configurations (Figs. 14, 15, 16, 43).



FIGS. 7-11. **Paxillus involutus.** 7, 8. Refractive bodies, some resembling chlamydospores, X 80. X 125. 9, 10, 11. Stages in the formation of fluid swellings in the hyphal wall, X 125.



FIGS. 12-13. **Stropharia aeruginosa**. Hyphal bridges with clamp-connections, X 80.

Remarks: In the appressed mat numerous refractive bodies, which stain deeply in phloxine, are formed terminally or intercalarily and do not detach from the hyphae (Figs. 17, 18).

Characteristic formations have been observed in all 3 isolates. The structures are first formed by the repeated twisting of the end of a single hypha, and then gradually becoming arranged almost parallel. They were observed mostly on the aerial hyphae (Figs. 19, 20) and only at the ends of hyphae.

Twisting of hyphae has been observed in other species as well, but in none assumed the specific tissue structure and the frequency that has been seen in this species.

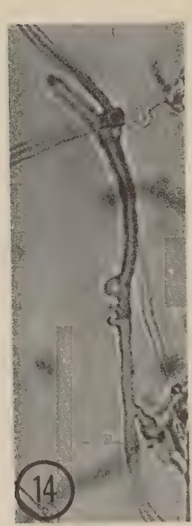
Clitocybe odora (Bull. ex Fr.) Kummer

In forest of Abies cephalonica, upper Mt. Parnis-Attiki, 13.XI.79, Coll. E. Kapsanaki - E. Papathanasaki, (ATHU-M 1655), (A-9); upper Mt. Parnis, 13.XI.80, Coll. M. Pantidou - Z. Gonou, (ATHU-M 1662), (A-109); Trikala-Korinthia, 2.XII.81, Coll. M. Pantidou - Z. Gonou (ATHU-M 1704), (A-176).

Cultural characters

Macroscopic: Mycelial mat 3-5 cm in 30 days, transparent, almost all growth submerged in all media used. Reverse ochraceous. Spot test with gum guaiac bluing in 5 minutes, but not consistently.

Microscopic: Hyphae 2.0-3.5 µm in diam., some up to 4.0-5.0 µm in diam., both with frequent side clamp-connections and clamps in the main hyphae and branches (Fig. 43), all non-amyloid. Submerged hyphae shorter and broader with refractive bodies,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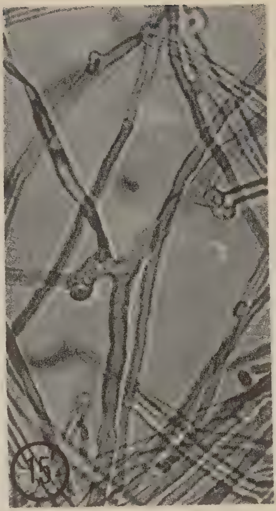
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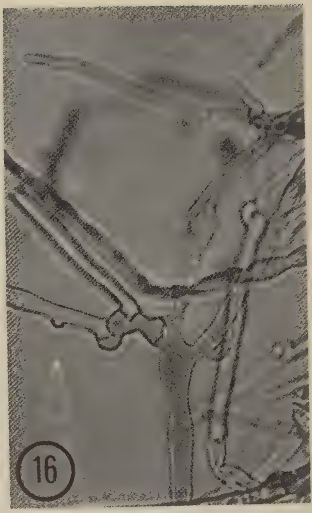
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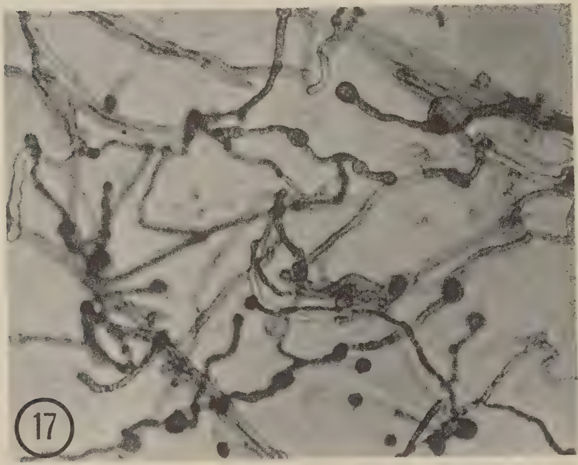
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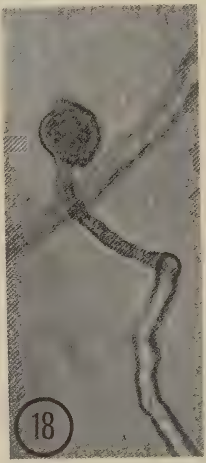
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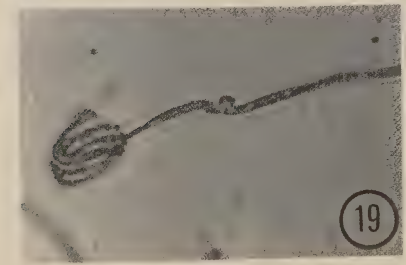
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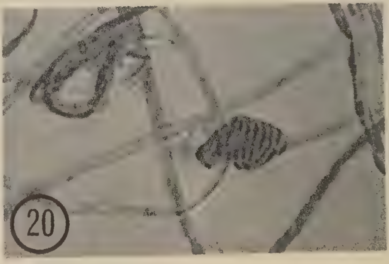
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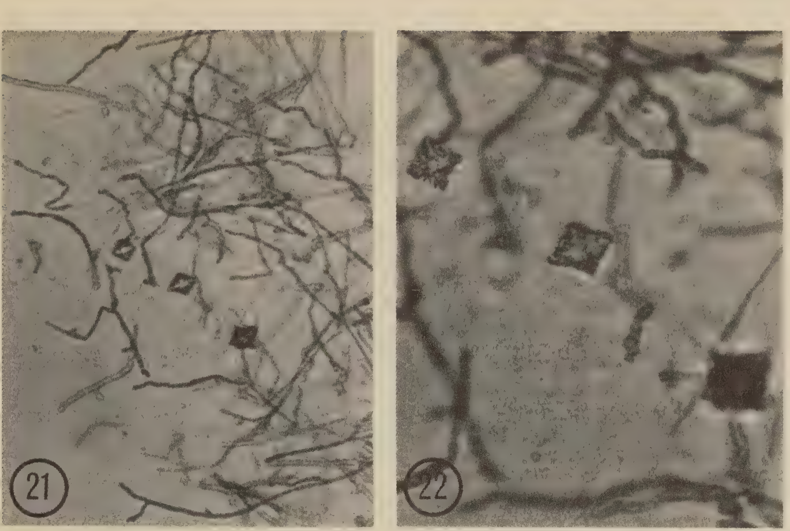


FIGS. 21-22. **Clitocybe odora**. Hyphae with crystalline material, X32, X80.

many with uneven walls and clamp-connections.

Remarks: Abundant crystalline material was observed between the hyphae (Figs. 21, 22).

Laccaria laccata (Scop. ex Fr.) Cooke

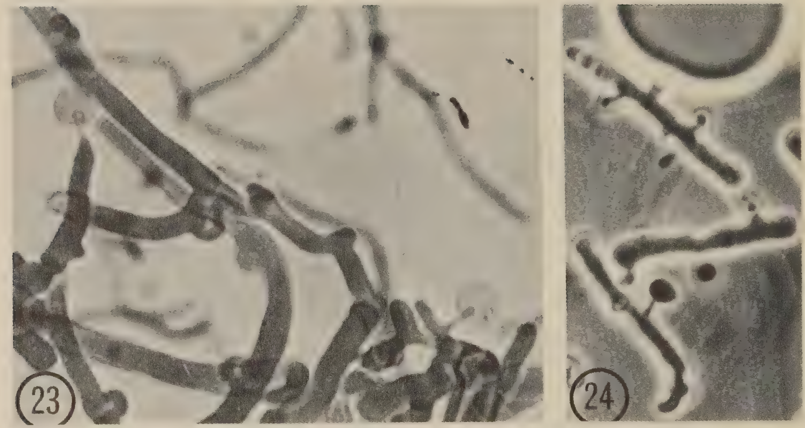
In forest of *Abies cephalonica*, upper Mt. Parnis-Attiki, 7.X. 80., Coll. M. Pantidou - Z. Gonou, (ATHU-M 1647), (A-88).

Cultural characters

Macroscopic: Growth fast, filling the plate in 30 days. Mycelial mat snow-white, surface with small tufts all over, giving a mealy appearance, separating cleanly from the surface of the agar as a thin sheet of paper. Reverse pale cream.

Microscopic: Hyphae in long threads, 2-3 µm diam., some up to 6 µm and mostly lactiferous with yellow contents. Clamp-connections frequent in various configurations (Fig. 43). In a 30-day old culture on PDA, in which part of the vegetative mycelium appeared in short, clamped hyphae, a small number of conidia were formed.

FIGS. 14-20. **Clitocybe geotropa**. 14. Two consecutive clamp-connections on the main hypha, X 80. 15. No clamp-connection on the main hypha, but clamp-connections on the two branches, X 80. 16. Group of branches and clamp-connections, X 80. 17, 18. Refractive bodies, X 32, X 80. 19, 20. Stages in the formation of terminal coils, X 80.



FIGS. 23-24. **Laccaria laccata.** 23. Terminal conidia. 24. Intercalary conidia, X 125.

Remarks: In the first stages, at certain, rather distant points, the cell wall extends to form a sterigma, which is continuous with the cytoplasm of the hypha. The sterigma is 5-8 µm long at the beginning but becomes shorter and broader as it develops a single conidium apically. The conidia resemble the basidiospores somewhat, are spherical, up to 7 µm diam., smooth to slightly roughened, hyaline, do not stain in phloxine, and are often formed between two clamps; they finally become detached. According to the terminology of Watling (1979), they should be referred to as "holoblastic solitary conidia" (Figs. 23, 24).

Lepista nuda (Bull. ex Fr.) Cooke
In forest of *Pinus halepensis*, Dionisos-Attiki, 20.XII.81, Coll. K. Katrakazou, (ATHU-M 1710), (A-221).

Cultural characters

Macroscopic: Mycelial mat filling the plate in 30 days, appressed, some aerial with a characteristic vinaceous gray colour. Reverse purplish.

Microscopic: Hyphae in long threads, 3-4 µm diam., non-amyloid with distant branching and prominent clamp-connections. In the submerged mat hyphae with irregular walls and clamp-connections, strands, papillate hyphae and a compact tissue with differentiated hyphae, some with intercalary swellings, some with cystidioid ends, some barrel-shaped.

Lepista sordida (Fr.) Singer
In forest of *Abies cephalonica*, upper Mt. Parnis-Attiki, 7. XI.80, Coll. M. Pantidou - Z. Gonou (ATHU-M 1695), (A-90).

Cultural characters

Macroscopic: Growth filling the plate in 30 days. Mycelial mat white, thin, with strands radiating up to the margin, not separating from the agar. Reverse pale.

Microscopic: Hyphae thin, 1.5 μm diam. and broader, 5 μm, non-amyloid, both with frequent clamp-connections, either as side-clamps or two clamps, one on the branch, or very rarely three clamps in paarige (Fig. 43). In the submerged mat many papillate hyphae, strands, and hyphae with uneven walls and clamp-connections may be found.

Leucopaxillus amarus (Alb. & Schw. ex Fr.) Kühner

In forest of *Abies cephalonica*, upper Mt. Parnis-Attiki, 13. XI.80, Coll. M. Pantidou - Z. Gonou, (ATHU-M 1664), (A-104); (ATHU-M 1632), (A-111).

Cultural characters

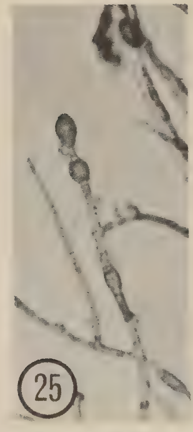
Macroscopic: Growth rather fast, filling the plate in 30 days in all media tested, pure white, cottony, remaining flat on the surface of the agar. Surface powdery in older cultures from presence of abundant chlamydospores. Reverse buff-chamois.

Microscopic: Hyphae in long threads of various diameters (2.2, 5.0, or 7.0-8.0 μm) with septa distant, branching simple, only one branch. Side clamp-connections frequent, in at least five configurations in relation to the main hypha and its branch (Fig. 43). In about 10-day-old cultures two types of hyphae can be distinguished: the vegetative hyphae which remain hyaline, non-granular, not staining in phloxine, and very granular hyphae, deeply staining in phloxine, which form chlamydospores. The latter hyphae have closely spaced septa with clamp-connections.

In the submerged mat mostly dendritic, frequently papillate hyphae with clamp-connections and abundant chlamydospores are present.

Remarks: From our study it appears that the formation of the chlamydospore starts by the modification of cells which generally are lying between two clamp-connections. The process appears to be the same as described by Watling (1979) for the chlamydospore formation in *Asterophora lycoperdoides* (Bull. ex Mérat) S.F. Gray, *i.e.*, by stretching of the cell wall, accompanied by swelling, condensation, and retraction of the cell content, and finally thickening of the wall and formation of retraction septa at both ends, separating the mature chlamydospore from the remaining segments of the hyaline cell bearing the clamp-connections; or the hyaline interspaces may be hyphal cells which do not form chlamydospores (Figs. 25, 26). A terminal chlamydospore in the branch of a hypha is shown in Fig. 27. Mostly they detach singly, rarely in twos, and the majority carry a segment of the hyaline hyphae at one or both ends. In the detached chlamydospores there is great variability in shape, in size varying from 6-12 μm in length and 3-7 mm in width, with the wall from 0.6-0.8 μm thick. Even after three months the chlamydospores did not germinate in water or in HgM medium.

In one of the isolates (A-111) cultured in HgM medium some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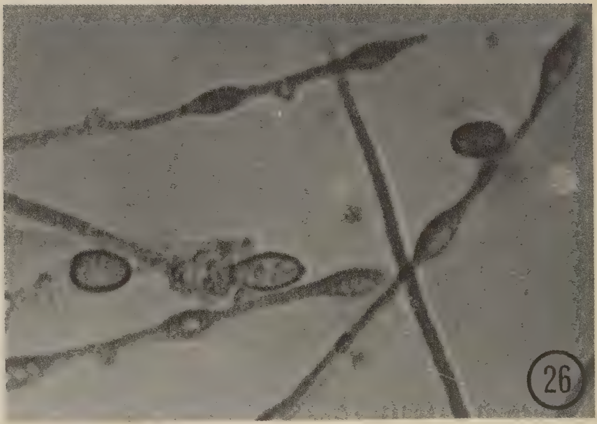
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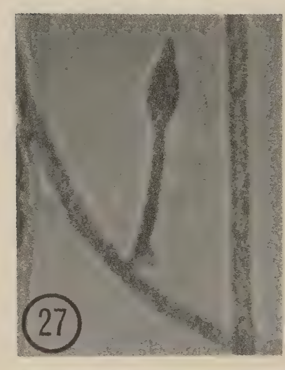
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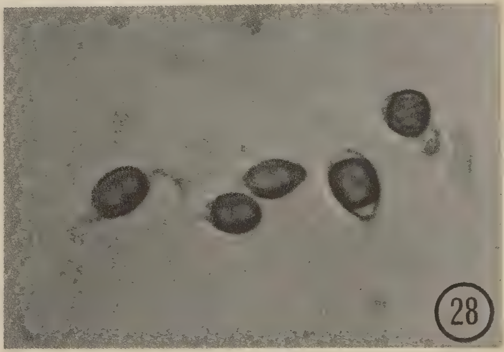
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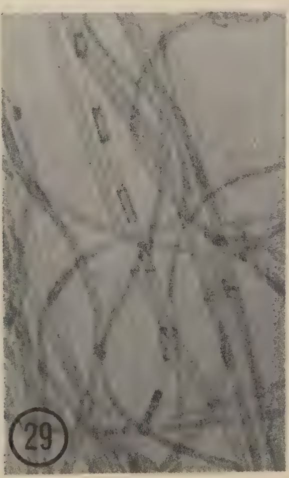
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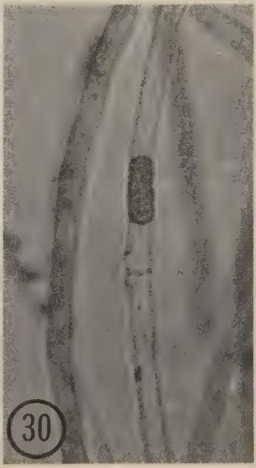
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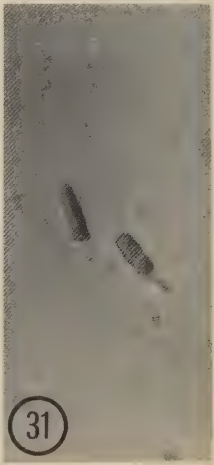
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hyphae in addition developed arthroconidia (Figs. 29, 30, 31), but these were rather rare.

Collybieae

Mycena seynii Quél.

On cones of Pinus halepensis, Thrakomakedones-Attiki, 17.XI.81, Coll. M. Pantidou - Z. Gonou, (ATHU-M 1717), (A-171); Tatoi-Attiki, 24.XI.81, Coll. E. Papathanasaki - Z. Gonou, (ATHU-M 1711), (A-173).

Cultural characters

Macroscopic: Both isolates have a characteristic growth. In the centre, for about 2 cm the mycelial mat becomes dark brown, the remaining 1.5-2 cm remains hyaline with some aerial white mycelium. Reverse honey.

Microscopic: Hyphae at margin are hyaline, long, 2-3 µm diam., non-amyloid, mostly with short branches and frequent side clamp-connections at the point of branching. At certain points some hyphae become characteristically coiled, forming a knot. On both sides of the knot the hyphae run close and almost parallel (Fig. 32).

Remarks: The coloured centre of the mycelial mat consists of a tissue with some degree of organization. The hyphae in the centre are dark yellow to brown and possibly disintegrate. They are surrounded first by pale hyphae which stain in phloxine, and then by a layer of refractive bodies and cystidia-like elements of various shapes with dark yellow contents (Fig. 33).

Cystodermateae

Cystoderma cinnabarinum (Alb. & Schw. ex Secr.) Fayod

In forest of Pinus halepensis, lower Mt. Parnis-Attiki, 21.XI.79, Coll. E. Kapsanaki, (ATHU-M 1690), (A-21).

In forest of Abies cephalonica, upper Mt. Parnis-Attiki, 23.X. 80, Coll. M. Pantidou - E. Papathanasaki - Z. Gonou, (ATHU-M 1692), (A-114).

Cultural characters

Macroscopic: Mycelial mat growing slowly but gradually filling the plate in 30 days, white, smooth at first, powdery with abundant outgrowths when older. Reverse pale cream.

Microscopic: The majority of hyphae in long threads 1.5-2 µm in diam., a few 4-5 µm diam., non-amyloid, with frequent side clamp-connections and clamp-connections in the main hyphae and in the branch at the same level (Fig. 43). Strands with twisting hyphae. In the appressed mat hyphae with abundant terminal or intercalary refractive bodies, often formed after a clamp, thin-walled, deeply staining in phloxine, yellow in Melzer's, not dissociating from the hyphae. Outgrowths in mycelial mat are composed of masses of ar-

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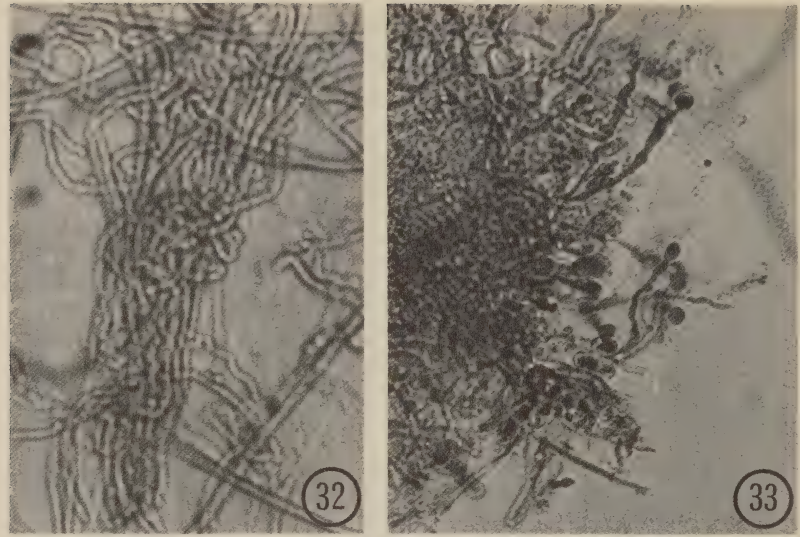
FIGS. 25-31. **Leucopaxillus amarus.** 25, 26. Chlamydospores formed between two clamp-connections, X 64, X 125. 27. Terminal chlamydospore, X 125. 28. Detached chlamydospores, X 125. 29, 30, 31. Arthroconidia, X 64, X 125, X 125.



FIGS. 32-33. **Mycena seynii.** 32. Strands, X 80. 33. Type of tissue, X 64.

throconidia. Arthroconidia originating in the vegetative mycelium, not in chains but separated by segments of hyaline, empty hyphae which do not stain in phloxine and which often bear one, two, or three successive clamp-connections (Figs. 34, 35).

Detached arthroconidia thin-walled, variable in shape and size, cylindrical, some slightly curved, truncate or rounded at both ends, 5-9(-12) x 4-5 µm (Fig. 36), hyaline or very pale yellow, deeply staining in phloxine, yellow in Melzer's.

Cystoderma granulosum (Batsch ex Fr.) Fayod

In mixed conifer wood, Tatoi-Attiki, 27.XI.79, Coll. E. Kapsanaki - E. Papathanasaki, (ATHU-M 1691), (A-33).

Cultural characters

Macroscopic: Growth fast, filling the plate in 20 days. Mycelial mat snow white, surface powdery. Reverse pale cream.

Microscopic: Hyphae in long, thin threads, the majority 1.5-2 µm diam., a few up to 7-8 µm diam., non-amyloid, a few lactiferous. Side clamp-connections frequent and clamp-connections in the main hypha and branches at the same level. Arthroconidia abundant in two-week old cultures, similar to those in C. cinnabarinum. No refractive bodies were found in this isolate.

Remarks: Following the terminology proposed by Watling (1979), the type of conidia in the two species of Cystoderma studied could be characterized as thallic arthroconidia since they originate in the vegetative mycelium which bears clamp-connections. The two species

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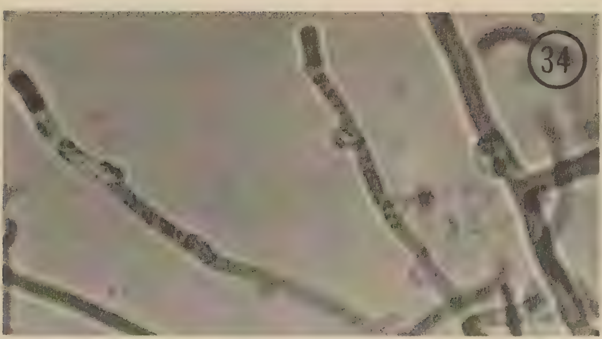
FIGS. 34-36. Arthroconidia in **Cystoderma cinnabarinum** and **Cystoderma granulosum**, X 160.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are similar in culture, but arthroconidia are longer in **C. granulosum** than in **C. cinnabarinum**, and without refractive bodies.

According to Watling (1979) arthric conidia on undifferentiated vegetative hyphae originate and are released either by the splitting apart of the two layers of double septa, or by the laying down of retraction septa which often leave empty hyphal segments in between each conidium. We believe that the arthroconidia in the cultures above are of the second type. They do not seem to originate from disarticulated clamp-connections, although the supporting hyphae have frequent clamp-connections. We assume that the arthroconidia are dikaryotic.

Arthroconidia have been reported in other species of Cystoderma, but were mainly found in basidiomes. Kühner (1969) reported presence of abundant "oidia" in the flesh of the pileus of C. amianthinum var. longisporum (Kühn.) Smith & Singer. He also reported that they were found in C. fallax Smith & Singer and in C. carcharias (Pers. ex Secr.) Fayod, but not in C. cinnabarinum nor C. granulosum basidiomes. Arthroconidia are reported by Heinemann & Thoen (1973) from the base of the stipe in C. tricholomoides Hein. & Thoen and on the pileus of C. aff. longisporum. Examination of our collections showed no arthroconidia present in the basidiomes of the two species we obtained in culture.

Tricholomeae

Tricholoma aurantium (Schaeff. ex Fr.) Ricken

In forest of Pinus halepensis, Tatoi-Attiki, 4.XII.81, Coll. K. Katrakazou, (ATHU-M 1713), (A-194); Dionisos, 20.XII.81, Coll. K. Katrakazou, (ATHU-M 1714), (A-217).

In forest of Abies cephalonica, Trikala-Korinthia, 2.XI.81, Coll. M. Pantidou - Z. Gonou, (ATHU-M 1698), (A-178).

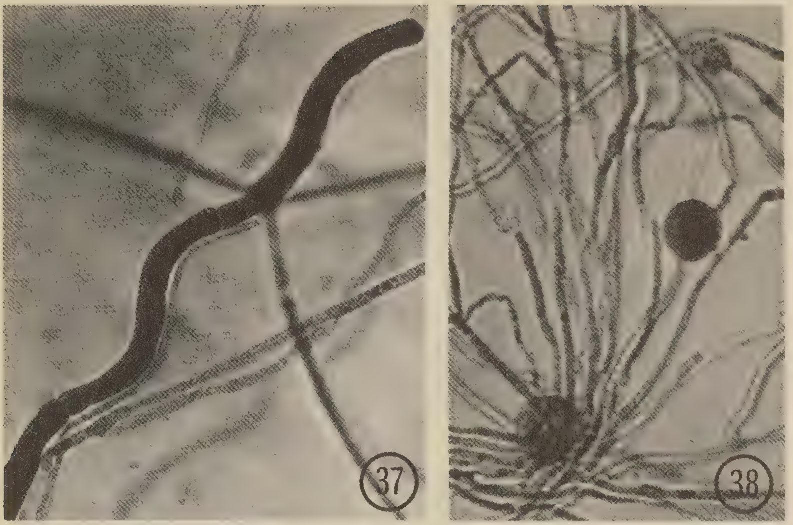
Cultural characters

Macroscopic: Growth slow, 3-4 cm in 30 days. Mycelial mat whitish to pale buff, appressed, little aerial. Reverse pale buff.

Microscopic: Hyphal system heterogeneous, of hyphae variable in width, 1.5-7.0 µm diam., lactiferous hyphae wide with pale yellow contents (Fig. 37). Numerous terminal or intercalary swellings, deeply staining in phloxine, not dissociating from the hyphae (Fig. 38). Branching simple, mostly one long branch at right or acute angles. Clamp connections absent in all isolates.

DISCUSSION

The information provided herein, although it spans several higher taxa, cannot on such a small sample provide any firm taxonomic conclusions. At the generic level, however, two more species in the genus Cystoderma are added to those species already known to produce thallic arthroconidia. At the specific level, in addition to recognising those species with anamorphs, useful information has been accumulated on cultural characteristics. In the future, when more species are studied, such characters may prove to be useful in distinguishing different taxa. In addition, it is always possible that a full description of the species in culture might help to identify unknown basidiomycetes isolated from soil, wood, or from roots of higher plants. The production of an anamorph in the cosmopolitan Laccaria laccata, however sparse, is of great inter-



FIGS. 37-38. **Tricholoma aurantium**. 37. Lactiferous hypha. 38. Refractive bodies, X 80.

est as this agaric is a common mycorrhizal partner. It has been cultured on tree roots in many laboratories, but this is apparently the first time a conidial state has been described.

There is no doubt that phenotypic variation found, when agarics are grown in pure culture and expressed in differences in rate of growth, colours, and texture of the mycelial mat, depends on the culture-medium. Thus the use of a standard medium in all future studies of the vegetative stage is of primary importance, possibly more so than temperature and light.

In contrast, the microscopic characters were constant in all the media used in this study. Variation in the frequency of such vegetative structures, however, did occur from medium to medium; thus the number of sclerotia produced by *Hebeloma eburneum* depended on the substrate. The ease of production of the anamorphic state depends on the species under study but also on the medium being used and apparently on the physiological status of the culture since it has been observed that conidiogenesis is not always formed uniformly throughout the mycelial mat. It is of course impossible to study microscopically the entire mycelial mat but by sampling different cultures and areas of these cultures we are confident the results illustrated above are meaningful.

In all the cultures of Agaricales studied (in solid medium) the growth of the aerial hyphae is monopodial, the branches arising at different distances behind the apex. Usually lateral branches arise immediately behind a septum, but not always. In contrast, hyphae which grow within the medium (submerged hyphae) rarely retain the monopodial type of growth. They exhibit short sections of hyphae with uneven walls, irregular, usually dendritic branching and frequent formation of refractive bodies; clamped hyphae were rare. The substrate therefore apparently modifies the type of growth of the vegetative mycelium.

It is assumed that, since our cultures were established from tissue of the teleomorph, the mycelial mat consisted of dikaryotic hyphae and therefore the presence or absence of clamp-connections could be taken as significant. From earlier observations it is apparent that within a genus the presence of clamp-connections is not consistent. It is however of great value at the specific level.

Illustrations of the various configurations of clamp-connections exhibited by the species studied accompany some descriptions above. Generally, in most species and therefore in the various families examined, side clamp-connections were most frequent. Clamp-connection in the main hypha and in one branch at the same level, or branch and clamp developed not at the point of the septum of the main hypha but below or above it, were relatively frequent. Paarige branching with or without clamps rarely occurred in the species studied.

The agaricoid fungi studied are distributed in several families of the Agaricales but they all showed significant cultural differences from members of the Boletales. Generally the boletes studied so far in culture, i.e., *Boletinus*, *Pulveroboletus*, and *Suillus* spp., have strongly coloured mycelial mats and often produce a coloured diffusate in the culture medium. In the agaricoid fungi only one species studied (*Paxillus involutus*) had a strongly coloured mycelial mat and produced a diffusing pigment. These two characters point to the close relationship between *Paxillus* and Boletaceae proposed by several authorities, e.g., Singer (1975), Kühner (1977).

The boletes frequently produce in culture sap hyphae; they also produce papillate hyphae and large quantities of amorphous waste material. In addition, in those species with clamp-connections on the hyphae, the clamps are often grouped, i.e., paarige branching is frequent. Such a phenomenon is rare in the Agaricales. In contrast, hyphae forming refractive bodies are more frequent in the agarics than in the boletes.

To facilitate distinction of the species described in this work we summarize them according to some of their basic characteristics:

I. **Production of teleomorph**
Collybia dryophila
Omphalotus olearius
Oudemansiella longipes
Panaeolus sphinctrinus
Pleurotus ostreatus

II. **Presence and type of anamorph**
Cystoderma cinnabarinum – thallic arthroconidia
Cystoderma granulosum – thallic arthroconidia
Hebeloma eburneum – sclerotia
Laccaria laccata – holoblastic conidia
Leucopaxillus amarus – chlamydospores
Pholiota aurivella – thallic arthroconidia

FIGS. 39-42. Basidiomes in Agaricaceae. 39. **Omphalotus olearius.** 40. **Collybia dryophila**, X 12.8. 41. **Oudemansiella longipes**, X 6.4. 42. **Panaeolus sphinctrinus**, X 12.8.

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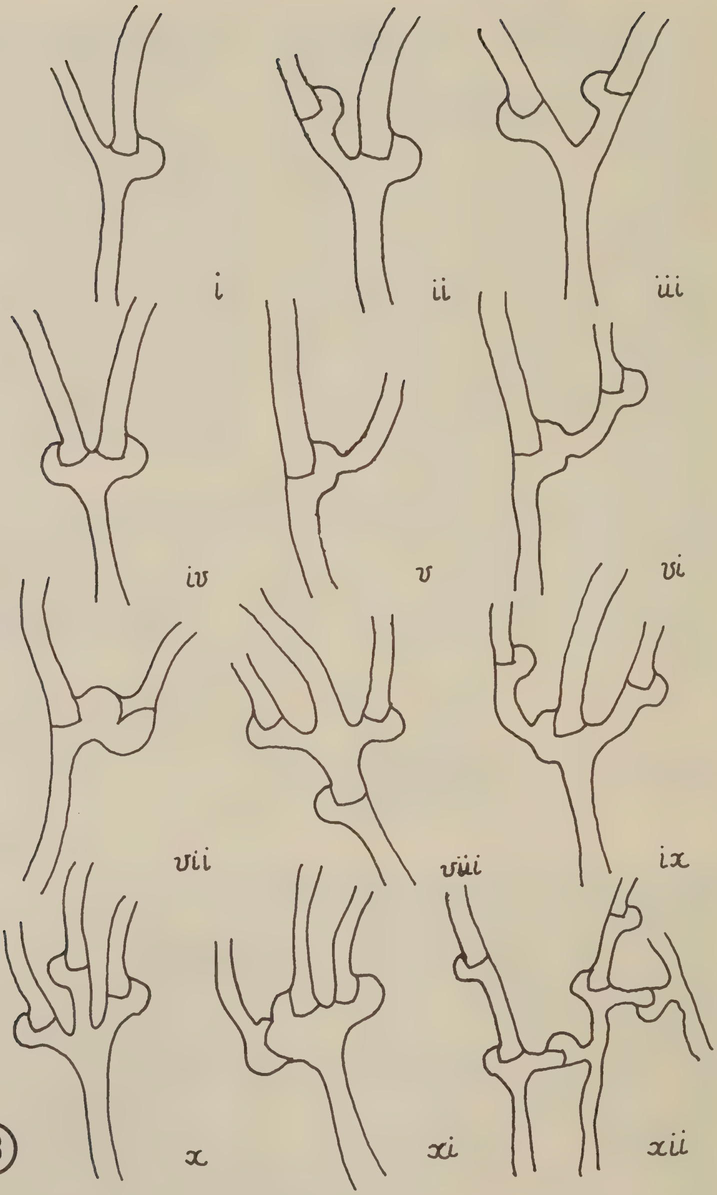
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III. Mycelial mats coloured
Mycena seynii
Oudemansiella longipes
Paxillus involutus
Pholiota aurivella

IV. Mycelial mats separating cleanly from the agar
Clitocybe geotropa
Laccaria laccata
Leucopaxillus amarus
Stropharia aeruginosa

V. Spot tests with gum guaiac positive
Agaricus silvicola
Clitocybe odora
Hebeloma eburneum
Mycena seynii

VI. Clamp-connections absent
Amanita ovoidea
Tricholoma aurantium
Agaricus silvicola

Clamp-connections rare
Amanita muscaria
Amanita pantherina
Coprinus comatus

Clamp-connections frequent
Cystoderma cinnabarinum
Cystoderma granulosum
Clitocybe geotropa
Clitocybe odora
Hebeloma eburneum
Laccaria laccata
Leucopaxillus amarus
Mycena seynii
Lepista sordida
Paxillus involutus

VII. Presence of refractive bodies
Agaricus silvicola
Clitocybe geotropa
Amanita pantherina
Cystoderma cinnabarinum
Cystoderma granulosum
Laccaria laccata
Mycena seynii
Paxillus involutus
Tricholoma aurantium

FIG. 43. Various configurations of clamp-connections. **Paxillus involutus**, i. iv, vi, vii, xi. **Stropharia aeruginosa**, ii, iii, iv, ix. **Clitocybe geotropa**, ii, xii. **Clitocybe odora**, viii, xii. **Laccaria laccata**, ii, iv, v, vii, x. **Lepista sordida**, i, ii, iv, xi. **Leucopaxillus amarus**, i, iii, iv, v, vi. **Cystoderma cinnabarinum**, iv.

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STUDIES ON XYLARIA OXYACANTHAE

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ABSTRACT

Teleomorphic stromata of Xylaria are described from Crataegus fruits and from Carya fruits collected in Michigan and Wisconsin. Cultures derived from stromata from these substrates are described and compared. It is concluded that the fungi from Crataegus and from Carya are X. oxyacanthae despite some teleomorphic and cultural differences. Xylaria oxyacanthae is compared with some other fruit-inhabiting fungi.

Xylaria oxyacanthae Tul. (≡ X. fuckelii Nits.) is widely distributed on Crataegus (hawthorn) fruits in Europe and North America. We have assumed that it also occurs on Carya fruits (hickory nuts) in USA but convincing data have been lacking. Consequently, a study was initiated to determine whether or not X. oxyacanthae on Crataegus fruits and the Xylaria on Carya fruits, respectively, are conspecific. The findings were compared with published data on some other fruit-inhabiting Xylaria species with which X. oxyacanthae has been confused.

MATERIALS AND METHODS

Stromata of Xylaria oxyacanthae were collected in southern Michigan and Dane Co., Wisconsin by EAS. Anamorphic stromata were collected in summer and collection sites marked in order that corresponding teleomorphic stromata could be obtained in the autumn.

Cultures were obtained by aseptically placing fragments of entostromata of anamorphic stromata on 4% malt extract agar and, later, transferring portions of resulting colonies to tubes of 2% potato dextrose agar. Isolations were made from stromata taken from fruits of Crataegus crus-galli L., C. punctata Jacq., C. lavallei Herincq., and an unidentified species which might be C. mollis Scheele. Cultures of a Carya-inhabiting Xylaria were made as described above from four stromata from a collection made near Albion, Michigan.

Cultural characteristics were studied on colonies growing in 9 cm Petri plates containing 2% potato dextrose agar with 5g/l yeast extract added (PDYA) and 2% Leonian's agar as modified by Bonar (1). Colony measurements and descriptions were made from plates which had been inoculated with 3 x 4 mm blocks bearing active mycelium, and incubated at 25°C under intermittent 12 h fluorescent light:12 h darkness. Observations were made at 7-day intervals and growth rates calculated after 3 wk incubation. Color nomenclature follows Ridgway (9) and plate numbers are designated following "R" in the descriptions.

Brightfield and differential interference microscopy were accomplished on material mounted in water or in lactophenol with cotton blue. Materials for scanning electron microscopy were prepared as previously described (2).

RESULTS

Observations were made upon cultures derived from eleven different isolations and data were compiled from collections made over a period of several years. However, for purposes of identification, the cultures of one particular isolate are described below. The selected cultures were initiated from the following anamorphic collection of Xylaria oxyacanthae: Stowell, E. A. no. Xy 825, 4.VII.1982. Mich. State Univ.arboretum, near Tecumseh, Lewanee Co., Michigan, on fruits of Crataegus sp. Teleomorphic collections were made from the same location and substrate, no. Xy 8232, I.IX.1982. These

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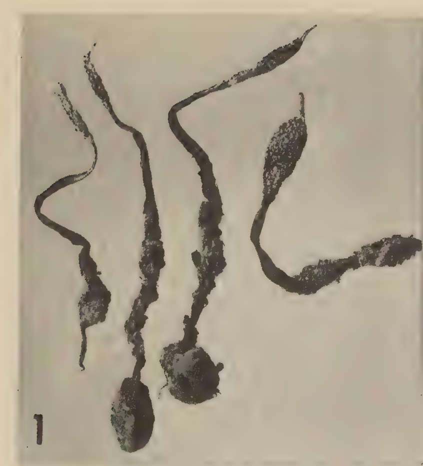
Figs. 1-4. Xylaria oxyacanthae. Fig. 1. Stromata of collection no. Xy 8232 on Crataegus fruits. X 1. Fig. 2. Stromata of no. Xy 6539 on Crataegus fruits. X 1. Fig. 3. Stromata on Carya fruits. X 0.7. Fig. 4. Portion of stroma showing splits in conidiogenous layer. X 8.



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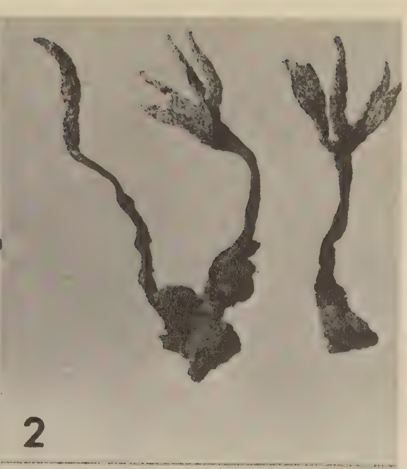

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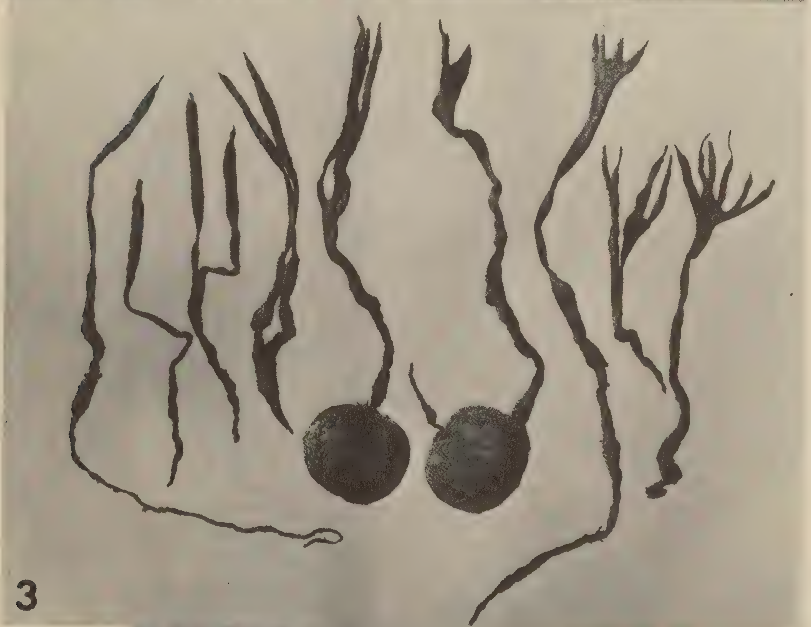

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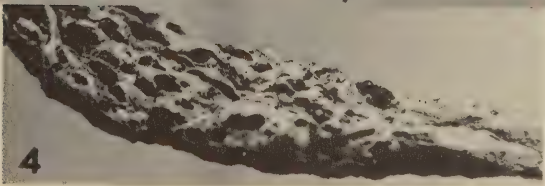

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anamorphic and teleomorphic states are described below.

Xylaria oxyacanthae

Anamorphic stromata cespitose to gregarious, growing from over-wintered buried fruits of Crataegus, erect, slender, terete to strongly compressed, simple or 1- or 2-branched, 2.0-4.0 cm long. Apices acute to acuminate, near salmon-buff (R,14), sterile, 1.0-7.0 mm long. Fertile heads terete to strongly compressed, 10-25 mm long x 1.0-3.0 mm thick, tapering towards both ends, pale tan (pale ochraceous salmon, R,15), powdery with conidia. Conidiogenous layer developing vertical splits 0.5-1.5 mm long. Stipes not sharply differentiated, terete to slightly compressed, 5-20 mm x 1.0-2.0 mm, with dark brown, firm, felted surface. Bases radicate, up to 20 mm long, irregularly enlarged up to 7.0 mm thick, dark brown, spongy, tomentose-felted, with adhering plant fragments and soil particles.

Conidiophores developed from ectostroma, forming a loose palisade. Conidiogenous cells slightly enlarged, tapering towards the expanded tips, bearing conidia in terminal position. Conidia and conidial scars often appearing in subterminal or lateral positions due to continued growth of conidiogenous cells. Conidia hyaline, 1-celled, obovate to subglobose, with flat basal scar, 3.0-5.0 x 2.0-3.5 (-5.0) µm.

Teleomorphic stromata (Fig. 1) with apices often shriveled or broken, near salmon buff (R,14) to dark brown. Fertile portion cylindrical to spindle-shaped, terete to strongly compressed, up to 5.0 mm thick. Former conidiophore layer shredded longitudinally, exposing perithecia (Fig. 4). Perithecia black, crowded, conspicuous, subglobose, 300-500 µm in diameter. Asci cylindric, 8-spored, long-stalked, 100-115 (-140) x 6.5-9.0 µm, 65-100 µm p. sp., with apical ring inverted hat-shaped, 2.0-2.5 x 3.0 µm, bluing in Melzer's iodine

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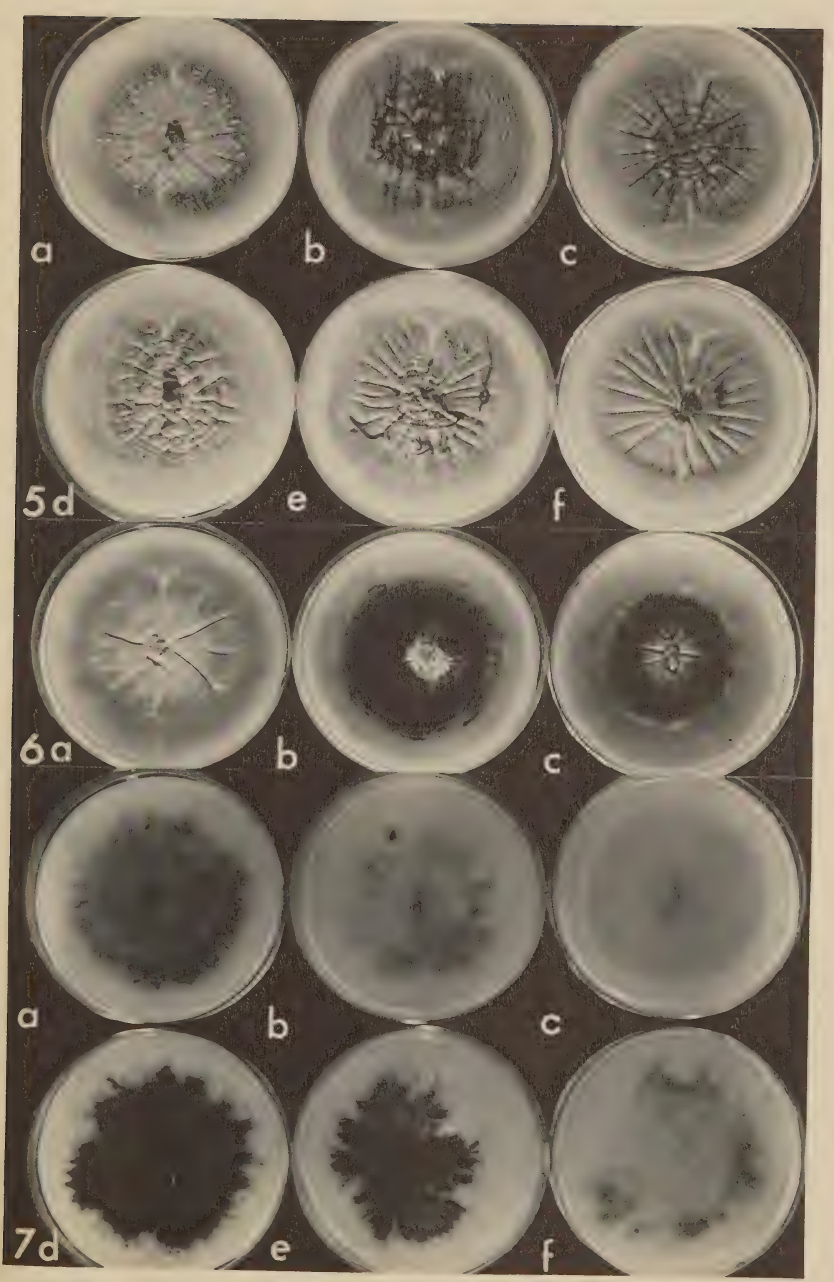
Figs. 5-7. Xylaria oxyacanthae. Figs. 5,6. Cultures on PDYA. X 0.4. Fig. 7. Cultures on Leonian's agar. X 0.4. Fig. 5, a-c. Cultures from stromata of single collection no. Xy 825 on Crataegus. Fig. 5, d-f. Cultures from stromata from three other Crataegus species. Fig. 6. Cultures from stromata on Carya, collection no. Xy 822. Fig. 7, a-c. Cultures from stromata from three Crataegus species. Fig. 7, d-f. Cultures from Carya.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reagent (Fig. 10). Ascospores uniseriate, dark olive brown, with straight germ slit running the full length of spore, ellipsoidal-inequilateral to navicular, 10.0-12.0 (-13.5) x 4.5-6.0 µm (Figs. 8,9). Immature ascospores lacking a cellular appendage.

Colonies on PDYA dense, with margins entire or undulate, white to pale pinkish buff (R,29) and vinaceous buff (R,40), tomentose to tomentose-felted, becoming raised and with well-developed radial furrows, developing regular narrow (1-3 mm) monochromatic zonation (Fig. 5b). Reverse pinkish buff (R,29) becoming avellaneous (R,40) or tawny olive (R,29) to wood brown (R,40) towards the center. Growth rate slow, 1.6 mm/day radial increment, covering 60 percent of plate in 3 wk.

Stromatal initials appearing in 2-3 wk near center of colony, cespitose to gregarious, pinkish buff (R,29). Stromata slender, cylindrical with acuminate apices, unbranched, reaching lengths of 10 mm by 4 wk, dark gray covered with pale, appressed tomentum, with pale pinkish buff (R,29) to cinnamon buff (R,29) tips (Fig. 17). Conidiophores typically confined to stromata, sparingly branched, arising from vertically-oriented hyphae of ectostroma, forming a loose palisade layer.

Conidiogenous cells slightly inflated, tapering

Figs. 8-19. _Xylaria oxyacanthae_. Fig. 8. Ascospores. X 3000. Fig. 9. Ascospore showing germ slit. X 3000. Fig. 10. Amyloid apical ring in ascus tip. X 4000. Fig. 11. Conidia from stroma produced in culture. X 2100. Fig. 12. Conidiogenous cell with attached conidium. X 2100. Fig. 13. Conidiogenous cells with conidia and conidial scars (arrows). X 2800. Fig. 14. Denticulate conidiogenous cell with conidium (arrows indicate denticules). X 4000. Fig. 15. Conidiogenous cell with apical and lateral (arrow) scars. X 6000. Fig. 16. Conidiogenous cell showing sympodial proliferation. X 4000. Fig. 17. Stromata of Xy 825 in PDYA culture. X 2.0. Fig. 18. Conidium forming at apex of conidiogenous cell (far right). Conidium to left of center is unattached. X 4000. Fig. 19. Conidiogenous cell with conidial scars clustered at apex (far right). X 7000.

Figs. 8-10 by brightfield microscopy from a mount in Melzer's reagent. Figs. 11-12 by differential interference contrast microscopy. Figs. 13-16, 18-19 by scanning electron microscopy. Fig. 17 by macrophotography.

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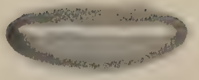
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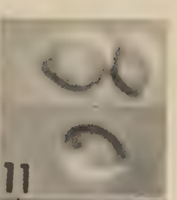
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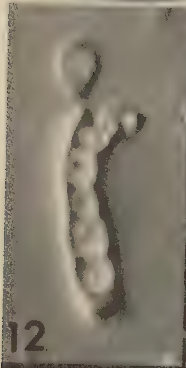
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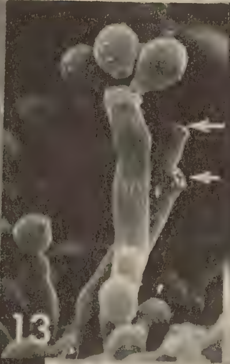
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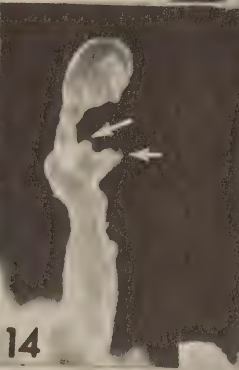
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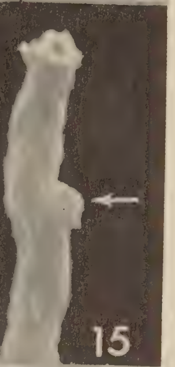
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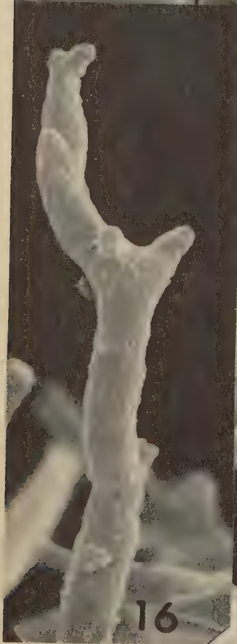
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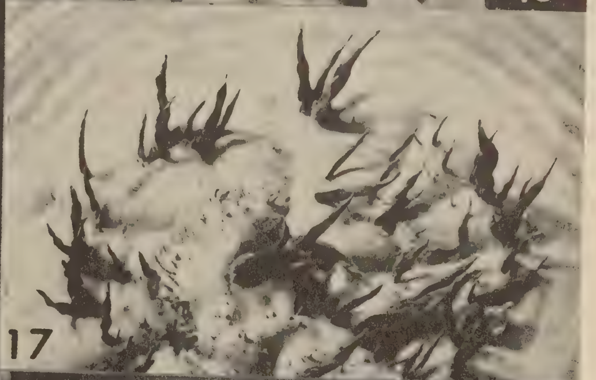
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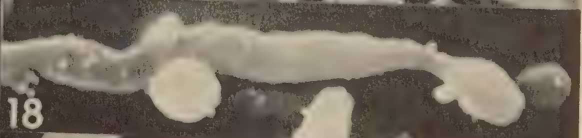
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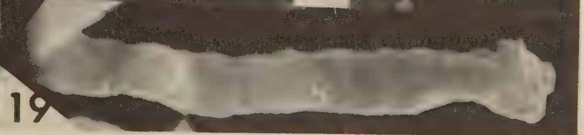
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upwards, producing terminal conidia; continued production of conidia from a limited area resulting in swollen distorted tips (Figs. 12-16, 18-19). Conidia hyaline, 1-celled, subglobose to obovate with flattened basal secession scar, (2.5-) 3.0-5.0 x 2.5-4.0 µm (Fig. 11). Detached conidia germinating on the stromata, producing 1-2 germ tubes from the ends.

The stromata described above are typical of the collections of _X. oxyacanthae_ made in Lewanee Co. on _Crataegus_ in 1982. However, earlier collections from this substrate and from this same area, as well as from sites near Battle Creek, Michigan and Madison, Wisconsin, show that stromata tend to be more robust and more branched, becoming palmately-digitate in some instances (Fig. 2). On the other hand, it is not uncommon following a dry summer to find smaller shrunken stromata which have failed to produce mature perithecia. This was, in fact, true of two of the marked collection sites in 1982. Conidiogenous cells and conidia were very similar in all of the collections examined. Ascospore size showed some variation, with the collections from southern Michigan tending toward spore lengths which exceeded 12.0 µm. However, the average ascospore lengths of the Michigan and the Wisconsin material were not significantly different.

The cultures of the other isolates from _Crataegus_ varied from the culture described above in several aspects, as shown in Fig. 5. In some the zonation was barely discernible, and the radial furrows more prominent. There were minor differences in the thickness and pigmentation of the colonies. Three of the seven isolates had formed no stromata by the end of 5 weeks, and one (Fig. 5a) had instead developed numerous small white pulvinate mounds upon which conidia were produced. However, the general appearance, coloration, and growth rates of all cultures were similar.

Both anamorphic and teleomorphic states of the _Xylaria_ from _Carya_ nuts closely resemble those described above. However, the stromata growing from _Carya_ nuts were frequently larger than any discovered thus far on _Crataegus_, in some cases reaching over 16 cm long (Fig. 3). Much, but not all, of this greater length represents increased length of the radicate bases which extend from the deeply buried nuts to the soil surface. The above-ground parts showed much less size difference. Conidiophores and conidia were similar to those found on the _Crataegus_ inhabitants. Ascus and ascospore sizes were within the lower portion of the size range given above, resembling those from the stromata collected on Crataegus in Wisconsin.

The cultures derived from hickory fruits resembled those from Crataegus in their slow rate of growth, the moderately raised colonies with radial furrows and narrow zonation, the entire to undulate margins, and the buffy tints in the fungal colonies (Fig. 6). They exhibited some of the same variations in zonation, definition of radial furrows, and colony thickness noted among the isolates from Crataegus. However, two of the Carya isolates (Figs. 6b, 6c) developed much darker pigmentation than any of the Crataegus isolates. It is noteworthy that none of the Carya isolates produced stromata, although one of them produced conidia on white pulvinate mounds on the agar surface, resembling one of the hawthorn isolates in this regard. The rate of mycelial growth of the Carya isolates was only slightly greater (1.9 mm/day ave.) than that of the Crataegus isolates (1.6 mm/day ave.).

Generally, the cultures on PDYA (Figs. 5,6) grew more vigorously and displayed better stromatal development than those on Leonian's agar (Fig. 7) and therefore they were used in the above description and comparisons. The growth on Leonian's agar was thinner, often submersed in the substrate, with margins more irregular and, in most cases, with less pigmentation. In those isolates which formed stromata, their production was almost entirely confined to PDYA.

DISCUSSION

The Xylaria stromata collected on Crataegus fruits in Michigan and Wisconsin are those of X. oxyacanthae, in the opinion of the authors. Although the ascospore size (10 x 4 µm) indicated by the Tulasne brothers (11) is slightly smaller than that determined in this study, the ascospores of their type material were reported by Joly (5) to be 9-12 x 3.5-6.0 µm (biometrically, 10.90± 0.065 x 5.04± 0.058 µm) and this is in close agreement with our data. The other described features show very good agreement with our data. This Crataegus-inhabiting species also is distinct from X. carpophila (Pers.) Fr. and X. persicaria (Schw. : Fr.) Berk. & Curt. with which it has been confused at different times (6, 7). The size and shape of the stromata produced in culture, the mode of conidiophore branching, the morphology of the conidiogenous cells, and the shape of the conidia of *X. carpophila* as described by Chacko and Rogers (2) are very different from those of the *Xylaria* on *Crataegus*. Moreover, immature ascospores of *X. oxyacanthae* examined with fluorescence microscopy do not show an evanescent cellular appendage as do those of *X. carpophila* and *X. persicaria* (see 10). The long straight germ slits found on the ascospores from stromata growing from hawthorn fruits are unlike the spiralling germ slits of *X. persicaria* described by Rogers (10). Martin (8) considered the long straight germ slit to be characteristic of *X. oxyacanthae* ascospores. The *Xylaria* on *Crataegus* is also clearly distinct from *X. magnoliae* Rogers and from *X. ianthino-velutina* (Mont.) Fr. as described by Rogers (10).

Based on available data, it is reasonable to believe that the fungus collected on fruits of *Carya* is also *X. oxyacanthae*. The markedly longer stromata growing from deeply buried hickory nuts might cause one to question this conclusion. However, it seems likely that the deeper burial of the hickory nuts (probably by rodents) promotes increased length of these stromata. In one instance, stromata were found growing from the mound of soil deposited beside an entrance to a woodchuck burrow. Burial of young developing stromata under this additional layer of earth would require that they grow considerably longer if they are to release their spores above ground in the normal manner. It is noteworthy that Ellis and Everhart (3) recorded a similar phenomenon in *Xylaria* stromata growing from peach "seeds". On the whole, the close similarities in both anamorphic and teleomorphic structures observed among stromata growing on natural substrates supports the conclusion that the *Crataegus*-inhabiting fungus and the *Carya*-inhabiting form are the same species.

The cultural differences noted among the isolates from *Crataegus* fruits and from *Carya* fruits are not sharply defined, but are largely differences of degree. Even the differences in production of dark pigments which are so striking if one compares the colony from *Crataegus* shown in Fig. 5e with the *Carya* isolate in Fig. 6b, become less distinctive when the entire series of isolates is considered. This integrative series of increasing pigmentation can be seen even better among the cultures grown on Leonian's agar (Fig. 7). Similar series can be observed for each of the variant features. While it is true that none of the *Carya* isolates developed stromata, there were also some *Crataegus* cultures which did not produce them. In light of the variation observed among cultures derived from stromata growing on the same substrate and in close proximity to one another, it seems reasonable to extend these continuum concepts to similar forms on the different substrates.

Conidia found on stromata in culture are more nearly globose than those occurring on collections from natural substrates. Greenhalgh and Chesters (4) reported similar differences in the conidia of *X. hypoxylon* (L. : Fr.) Grev. produced under these different conditions. The more humid atmosphere and the more constant moisture supply available to the fungi in culture could perhaps cause such differences.

The range of natural substrates upon which *X. oxyacanthae* occurs is uncertain. The Tulasnes described it from *Crataegus oxyacantha* L. in France (11). Lloyd (6) reported that he identified the Tulasne fungus growing on fruits of *Cornus florida* L., but considered *X. persicaria* to be its correct name. We do not know the species of the fungus discussed by Lloyd, and he expressed some uncertainty regarding the identity of the substrate. Later, Lloyd (7) reported the same fungus collected in New York on hickory nuts. It seems probable that this collection was *X. oxyacanthae*, although Lloyd listed it as *X. carpophila*. In addition to the collections cited earlier, Stowell has collected anamorphic stromata which closely resemble those of *X. oxyacanthae* from fruits of *Quercus* sp. Unfortunately, none of these fruiting bodies bore mature ascospores and, hence, positive identifications were not made.

These differences noted in substrates, stromatal size, and cultural characteristics suggest that *X. oxyacanthae*, as it exists in USA, is a variable species. Although future studies may indicate that one or more host-specific varieties should be recognized, at present, there is insufficient evidence to warrant such separation.

ACKNOWLEDGMENTS

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MYCOTAXON

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IDENTIFICATION OF AGGRESSIVE AND NON-AGGRESSIVE STRAINS OF CERATOCYSTIS ULMI BY POLYACRYLAMIDE GRADIENT GEL ELECTROPHORESIS OF INTRAMYCELIAL PROTEINS[1]

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ABSTRACT

Soluble proteins extracted from the mycelium of 14 strains of Ceratocystis ulmi were separated on SDS and non-SDS polyacrylamide gradient gel electrophoresis. The protein patterns were compared and their use as a taxonomic criterion discussed. Electrophoretic protein patterns proved useful in characterizing aggressive and non-aggressive strains of C. ulmi

INTRODUCTION

Since the discovery of aggressive and non-aggressive strains of Ceratocystis ulmi (Buism.) C. Moreau in Britain (10), a number of studies on the variation of this fungus and its pathogenicity have been carried out in Europe, North America and South West Asia. The results of these investigations showed that pathogenicity of C. ulmi is associated with synnemata formation (21, 32), toxin production (32), optimal growth temperature (4), cultural characterisitics on agar medium (10, 20, 21, 29, 32) and utilization of amino acids from liquid medium (22). Some inconsistencies in these results, however, have also been reported (29, 32). This discrepancy resulted partly from the use of different types of agar, different ages of the isolates, and different incubation tempera-

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tures (3, 12). Therefore, an accurate method for determination of aggressive and non-aggressive strains of C. ulmi is needed.

Gel electrophoretic patterns of soluble proteins extracted from fungal mycelium have received considerable attention and have shown some success in differentiating species, formae speciales, or physiological races of various fungi (5, 6, 7, 8, 13, 14, 17, 24, 25, 31). However, some investigators have shown so much variation in protein patterns that they do not recommend the use of soluble protein patterns as taxonomic criteria (13, 15, 16, 28, 30, 31).

To now, many reports have shown that electrophoretic protein patterns were useful characteristics for the distinction of fungi and algae at species level (18). Little information is available on relationship between protein patterns and pathogenically distinct strains of the pathogens.

The main objective of this study is to investigate whether SDS and non-SDS polyacrylamide gradient gel electrophoresis of soluble protein patterns are of any value for the characterization of aggressive and non-aggressive strains of C. ulmi. Correlation between isoenzyme patterns and pathogenicity of C. ulmi have already been reported elsewhere (1).

MATERIALS AND METHODS

Fourteen strains of C. ulmi, namely, SMF, Q412, CESS16K, RR2, RR11 (from Canada), MAB, S116, ND, VA (from the United States), W1, W6 (from the United Kingdom), WRB2-1, A1 (from Iran), H6 (from the Netherlands), which have been evaluated for pathogenicity (11, 31), were used in this investigation. Strains S116, Q412, SMF, MAB, W6, WRB2-1 and A1 have been known as non-aggressive while RR2, H6, ND, CESS16K, W1, VA and RR11 as aggressive. They were grown in liquid medium (32) as still cultures for 15 days at 22 °C. At the end of the incubation period, the mycelium was harvested by filtering on Whatman No. 1 filter paper, and washed 5 times with distilled water. The resulting mycelial mat was then frozen in dry ice-acetone solution.

For the extraction of soluble proteins the method of Stipes (31) was employed. Frozen mycelium was ground for 1 min at top speed with Polytron homogenizer (Brinkmann Instruments) in a dry ice-acetone solution (15 ml/g wet weight of mycelium). The resulting slurry was filtered on Whatman No. 1 filter paper, and washed 3 times with dry ice-acetone solution. This dry mycelial powder is referred to as acetone powder.

Fifty mg of acetone powder was extracted for soluble proteins in 1 ml of a 4 mM $NaHCO_3$ solution (pH 7.6) overnight at 4°C. The extract was centrifuged at 18000 rpm for 30 min. The resultant pellet was discarded. The quantity of soluble proteins in the supernatant was determined by Bradford's method (2) using bovine crystalized albumine as standard and Coomassie Blue G-250 as dye reagent (Bio-Rad protein assay kit, Bio-Rad Laboratories).

Samples for SDS gel electrophoresis were prepared by adding equal amounts of Laemmli's (23) sample buffer containing 20% Glycerol, 2% SDS (Sodium dodecylsulfate), 2% 2-mercaptoethanol, 0.062 M Tris-HCl (pH 6.8) and a dash of Bromophenol Blue as tracking dye to the protein samples. The samples were stored in a freezer at -20 °C. Immediately before loading on the gel, the sample solutions were boiled for 1 min. Sample solutions standardized to about 70 ug protein per sample were loaded on the gel. Bio-Rad low molecular weight markers served as references.

A continuous polyacrylamide gradient slab gel was used for electrophoresis. Slab gels, 23x14x0.15 cm, were made with a Pharmacia Gradient Mixer GM-1 equipped with a peristaltic pump P-1 at a flow rate of 5 ml/min. The concentration of the gradient gel ranged linearly from 8 to 15%. The gel was prepared from a stock solution of 30% Acrylamide (w/v) and 0.8% Bis (N,N',-methylene-bis-acrylamide) (w/v) (23). A 4 cm long stacking gel (5%) was laid on the top of the running gel. The running gel contained 0.375 M Tris-HCl (pH 8.9) and O.1% SDS. The gel was polymerized chemically by adding 0.05% ammonium persulphate and 0.05% TEMED (N,N,N',N'-tetraethylenediamine). The discontinuous buffer system was the same as described by Laemmli (23). The electrode buffer contained 0.052 M Tris-Glycine and 0.1% SDS.

Electrophoresis was carried out at a constant 200 volts until the distance of the Bromophenol dye was at 1 cm from the bottom of the running gel. After separation, the gel was first stained with 0.1% Coomassie Brilliant Blue R in PAGE fixative (methanol: acetic acid: water = 45: 10: 45) at 60 °C for 1 hour and then fixed in PAGE fixative at 60 °C for another hour. The gel was destained in a solution of 5% methanol and 7% acetic acid.

For non-SDS polyacrylamide electrophoresis, protein samples and gels were prepared according to the method described above but without SDS. Non-boiled protein samples were loaded on the gel.

RESULTS AND DISCUSSION

Electrophoretic soluble protein patterns of 14 strains of *C. ulmi* on SDS polyacrylamide gradient gel are shown in Fig. 1. About 60 Coomassive Blue staining proteins were distinguishable for each strain. Based on these protein patterns the strains of *C. ulmi* can be separated into two groups and designated as NA (non-aggressive) and AG (aggressive) groups (Fig. 1). The most striking differences occur in the region between 14K and 45K daltons molecular weights (Fig. 2). All strains of AG group lack the protein band C; on the other hand, they possess protein bands B and D. In addition, both groups also differ in the density of at least 2 protein bands (A and E) in the region of 31K and 21K molecular weights. The density of these 2 bands in the NA group is much greater than in the AG group (Fig. 2).

All 5 strains of the NA group have been classified as non-aggressive based on cerato-ulmin production, cultural characteristics and inoculation tests on elms (32). In contrast, with the exception of strains WRB2-1 and A1, the other 7 strains of the AG group have been classified as aggressive ones (32). Gibbs *et al* (11) and Takai (32) identified strains WRB2-1 and A1 as non-aggressive. These two strains, however, produce the toxin cerato-ulmin at similar levels as the aggressive strains do (32). Furthermore, any given protein is a relative direct expression of the genetic information (9), thus indicating that strains WRB2-1 and A1 are closely related to the aggressive strains and therefore should be classified within this group. In addition, experiments should be carried out to reassess the pathogenicity of the two strains. The similarity in isoenzyme patterns of alcohol dehydrogenase, esterase and peroxidase of these two strains to the aggressive group of *C. ulmi* (Fig. 4) is a further support for such conclusion. These isoenzyme experiments were carried out in 7.5% polyacrylamide slab gel free of SDS. Isoenzyme patterns were visualized according to the methods of Shaw *et al* (27) and Hammerschmidt *et al* (19).

Aggressive and non-aggressive strains of *C. ulmi* can also be differentiated by non-SDS electrophoretic protein patterns in

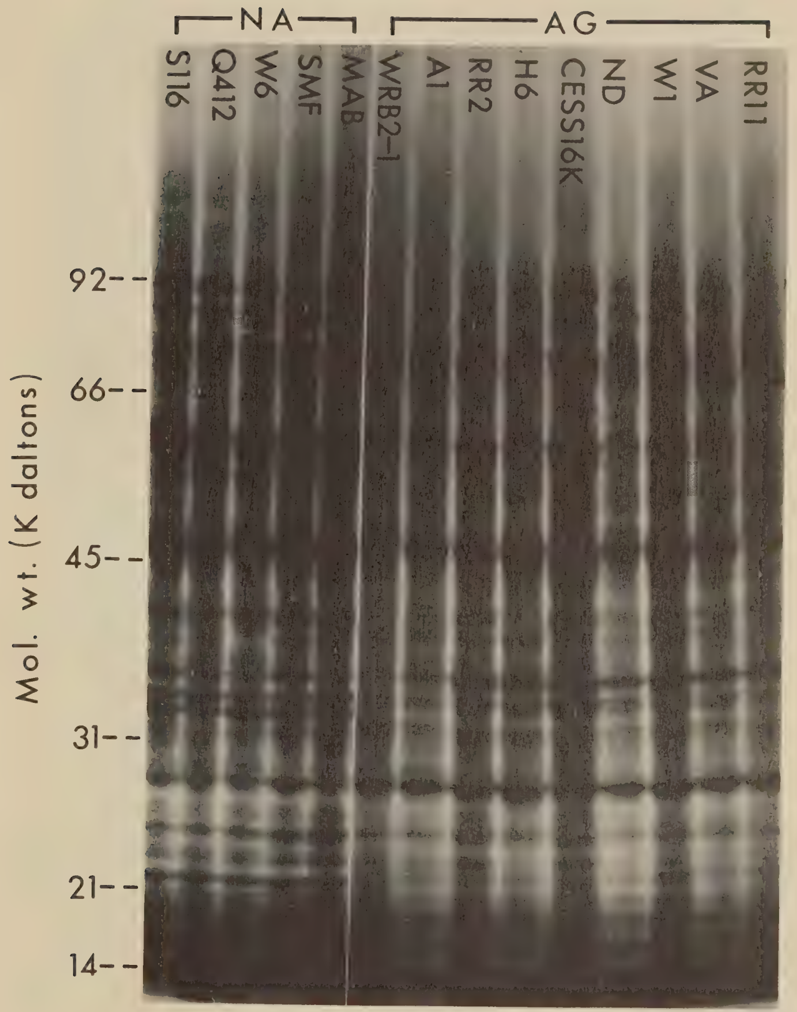
NA
AG
S116
Q412
W6
SMF
MAB
WRB2-1
A1
RR2
H6
CESS16K
ND
W1
VA
RR11
Mol. wt. (K daltons)
92
66
45
31
21
14

Fig. 1. Electrophoretic soluble protein patterns of 14 *C. ulmi* strains on SDS polyacrylamide gradient gel. Note two distinct groups: NA (non-aggressive) and AG (aggressive). The most striking differences are in the region of 14K to 45K molecular weight proteins.

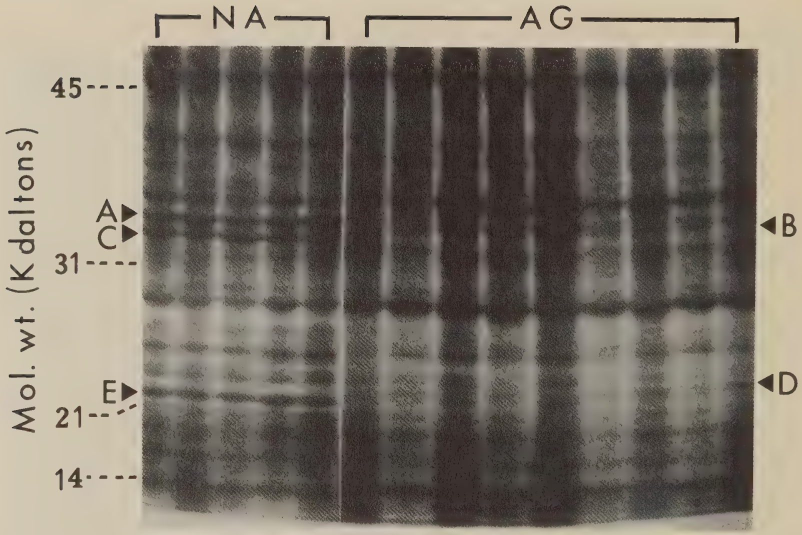

Fig. 2. Region of 14K to 45K dalton proteins from figure 1 showing 5 distinct proteins, A, B, C, D and E. Arrangement of C. ulmi strains is the same as in figure 1. NA, non-aggressive; AG, aggressive.

homogeneous or gradient gel. Non-aggressive strains of this pathogen can readily be distinguished by two fast moving protein bands (Fig. 3). Fig. 3 also shows that the number of protein bands in the non-SDS gel is considerably smaller than the number in the SDS gel. A total of about 15 proteins were discernible on this gel. This difference in number of protein bands is attributed to the effect of SDS on protein complexes. SDS is known as a powerful protein denaturant and solubilizing agent, which liberates proteins from complexes and eliminates aggregates (26).

In his study on protein patterns of 4 isolates of C. ulmi, Stipes (31) reported striking intraspecific similarities and no relevance to their pathogenic activities. He also depicted a minimum of 12 protein bands and a maximum of 14 for these 4 isolates. His results and our findings indicate the advantage of using SDS in the study of soluble protein patterns.

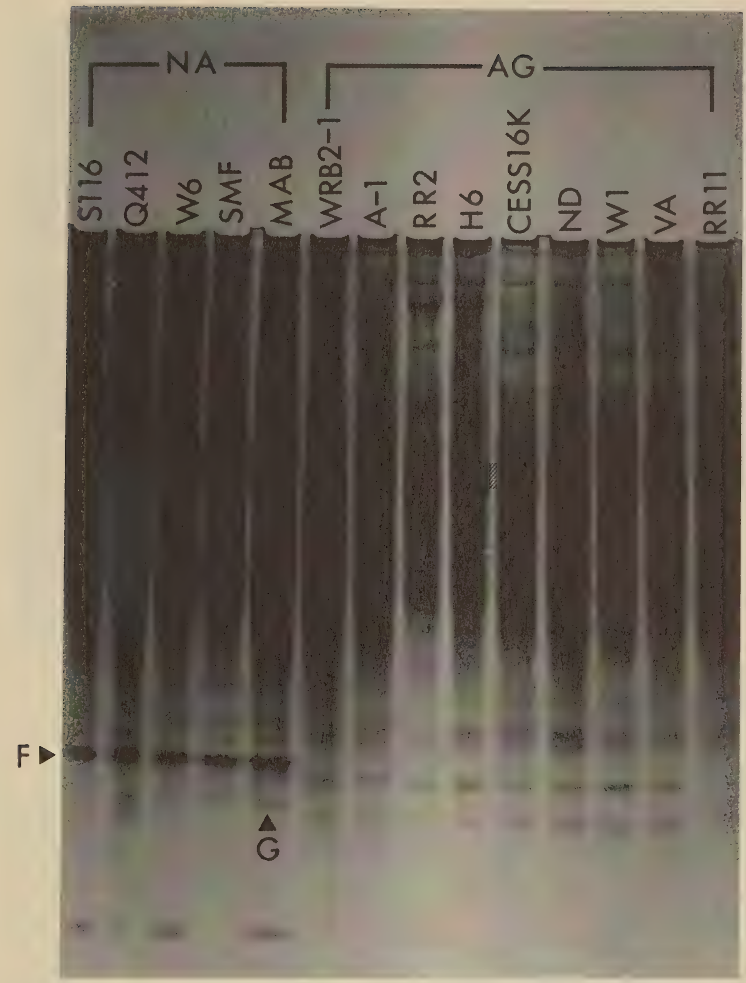
NA
AG
S116
Q412
W6
SMF
MAB
WRB2-1
A-1
RR2
H6
CESS16K
ND
W1
VA
RR11
F
G

Fig. 3. Electrophoretic soluble protein patterns of 14 C. ulmi strains on non-SDS polyacrylamide gradient gel. Note the presence of 2 fast moving protein bands F and G of NA group. NA, non-aggressive; AG, aggressive.

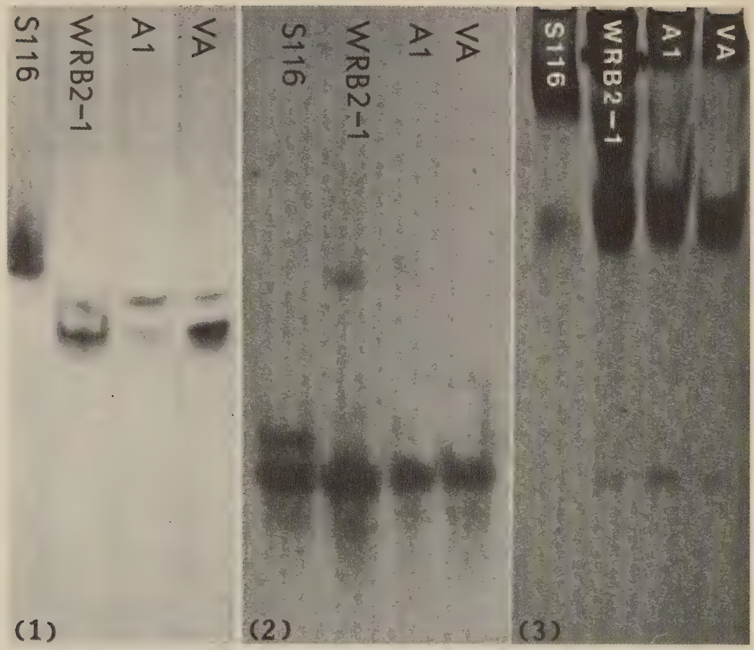

Fig. 4. Isoenzyme patterns of alcohol dehydrogenase (1), esterase (2) and peroxidase (3) of strains S116 (non-aggressive), WRB2-1, A1 and VA (aggressive). Note the similarity in isoenzyme patterns of strains WRB2-1, A1 and VA.

Results of this study suggest that SDS and non-SDS soluble protein patterns are useful in characterizing aggressive and non-aggressive strains of C. ulmi. The nature and biological significance of these distinct low molecular weight proteins are under investigation.

ACKNOWLEDGMENT

The technical assistance of Mrs. Shahida Rashid is gratefully appreciated.

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DIFFERENTIATION OF AGGRESSIVE AND NON-AGGRESSIVE ISOLATES OF CERATOCYSTIS ULMI BY GEL ELECTROPHORESIS OF INTRAMYCELIAL ENZYMES

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SUMMARY

Seven enzyme systems in fifteen isolates of Ceratocystis ulmi have been analysed by polyacrylamide gel electrophoresis. A correlation has been found between isoenzyme patterns of alcohol dehydrogenase, peroxidase, polyphenoloxidase and esterase, and aggressiveness of isolates grown under still or shake conditions. The banding pattern of hexokinase was also correlated with aggressiveness when isolates had been grown under still conditions. Isoenzyme patterns of malate dehydrogenase and phosphoglucomutase showed no correlation with aggressiveness. In addition, aggressive isolates differed from non-aggressive ones in their protein content and yield of acetone powder in still culture, but not in shake culture. The use of isoenzyme analysis is proposed as an accurate means of separating aggressive and non-aggressive isolates of C. ulmi.

INTRODUCTION

Ceratocystis ulmi (Buism.) C. Moreau is the causal agent of Dutch Elm Disease. Two obvious gaps in our current knowledge of the biology of the pathogen are the lack of understanding of the mechanisms of aggressiveness, as well as the absence of a reliable method to measure the extent of genetic variability within the species. As long as the limits of this variation are not defined, failures in disease control programs must be expected.

Aggressiveness in C. ulmi has been correlated with many cultural characteristics. Gibbs and Brasier (1973) described "aggressive" isolates as "fluffy" and fast-growing in culture, whereas "non-aggressive" isolates appeared as "waxy" and slow-growing. The aggressive isolates have been reported to reach optimal growth at a lower temperature (Brasier et al., 1981), to produce more coremia (Schreiber and Townsend, 1976; Hindal et al., 1981) and to release more of the toxin cerato-ulmin in culture (Takai, 1980). Some authors, however, have reported inconclusive attempts to correlate aggressiveness and cultural characteristics (Schreiber and Townsend, 1976; Fleming, 1980).

Recent work from this laboratory indicated that in liquid still culture medium, the aggressive isolates grew on the surface and had greater amino acid uptake and cerato-ulmin production than non-aggressive isolates which grew submersed (Hubbes and Jeng, 1981). Based on their data, these authors speculated that aggressive and non-aggressive isolates might differ in their metabolic pathways and that isoenzyme analysis might reflect these differences. The purpose of our study is to investigate the possibility of using isoenzymes as biochemical markers of aggressiveness in Ceratocystis ulmi.

MATERIALS AND METHODS

Isolates of C. ulmi and culture conditions.

Fifteen isolates which had previously been evaluated for their aggressiveness (Takai, 1980; Hubbes and Jeng, 1981) were investigated. The aggressive group consisted of isolates CESS 14K, CESS 16K, TOR, RR2, RR11 from Canada, VA from U.S.A., W2 from England and H6 from the Netherlands. The non-aggressive group included isolates Q311, Q412, P1, SSMF from Canada, M273 from U.S.A. and W9 from England. Isolate SSM (from Canada) was considered to be intermediate based on data from Hubbes and Jeng (1981).

The isolates were first subcultured on 4% PDA for one week. Mycelium discs, 5 x 5 mm in diameter, were then cut from the periphery of the colonies and asceptically transferred into 125 ml Erlenmeyer flasks containing 50 ml of sterile medium as described by Takai and Richards (1978). The flasks were incubated in the dark at 24oC, with and without agitation; in the first case, the cultures were placed on a rotary shaker (120 RPM). Mycelia were harvested after 10 days of incubation. The experiment was repeated twice.

Protein extraction and quantification

Soluble proteins were extracted following the method described by Stipes (1970). Mycelia and spores were harvested and filtered through Whatman No. 1 filter paper, and rinsed with 100 ml of distilled water to remove the medium. Fungal tissue was then ground in cold acetone (-20oC; 10 ml/g fresh weight) using a Brinkmann Polytron apparatus set at high speed. The slurry was filtered through Whatman No. 1 filter paper and washed with 30 ml of cold acetone. The resulting crust was rapidly worked into a fine powder, using a clean spatula. Soluble proteins were extracted by adding 0.004 M sodium bicarbonate (1 ml of $NaHCO_3$/50 mg powder). The solution was mixed for 10 seconds and left overnight at 4°C in the dark before centrifugation was carried out for 30 minutes at 40,000 x g. The supernatant was collected and its protein content was assayed with Coomassie Blue (Bio-Rad Protein Assay Reagent) in a Zeiss PMQ3 spectrophotometer at 595 nm. Crystallized bovine serum albumin (obtained from BDH) was used as standard.

Electrophoresis

Samples for electrophoresis were prepared by adding one volume of the supernatant to one volume of buffer (0.062 M Tris-HCl in glycerol and distilled water at 1:4 V/V, and a dash of Bromophenol Blue as tracking dye; pH 6.8). Electrophoresis was performed on a Bio-Rad Protean Dual 16 CM Slab Cell. The gels contained 7.5% polyacrylamide, 0.377 M Tris-HCl (pH 8.9) and were chemically polymerized by the addition of 0.05% (W/V) ammonium persulphate and 0.05% (V/V) N,N,N',N'-tetramethylethylenediamine (TEMED). The electrode buffer consisted of 0.052 M Tris-glycine, pH 8.9. Comparable amounts of proteins were applied for all samples and electrophoresis was carried out at 200 Volts with the current averaging 45 mA at the beginning of the run. The apparatus was turned off when the tracking dye had migrated 10 cm from the origin.

Staining for enzymes

Alcohol dehydrogenase, malate dehydrogenase, phosphoglucomutase, hexokinase and esterase were visualized by the methods described by Shaw and Prasad (1970) and Siciliano and Shaw (1976). Peroxidase and polyphenoloxidase were assayed by using L-DOPA as substrate (Kieliszewska-Rockicka, 1980). Chemicals used in the stains were purchased from BDH and Sigma.

Statistical analysis

Data of protein content and acetone powder yield were subjected to analyses of variance. 'F' values were calculated and compared according to methods described by Sokal and Rohlf (1969) for analysis of variance with unequal sample sizes.

RESULTS

Appearance of the isolates

In still culture, the isolates exhibited growth patterns similar to those previously reported by Hubbes and Jeng (1981). The aggressive isolates grew on the surface of the medium, and the non-aggressive ones grew submersed. There were variations within the groups, notably among the aggressive isolates, some of them producing more aerial mycelium than others. Isolate SSM grew similar to aggressive isolates. In shake cultures all isolates produced yeast-like budding spores and little mycelium, and the overall appearance was the same within and among the groups.

Yield

No measurements of dry weight of fungal tissues were made. The amount of dry acetone powder collected, however, is an indicator of the amount of mycelium and spores produced in culture (Stipes, 1970). As shown in Fig. 1, the aggressive isolates gave a higher yield than the non-aggressive ones when grown under still conditions. In shake culture, the values for the two groups were statistically similar. The yield from isolate SSM was comparable to the yield from aggressive isolates, in both still and shake cultures.

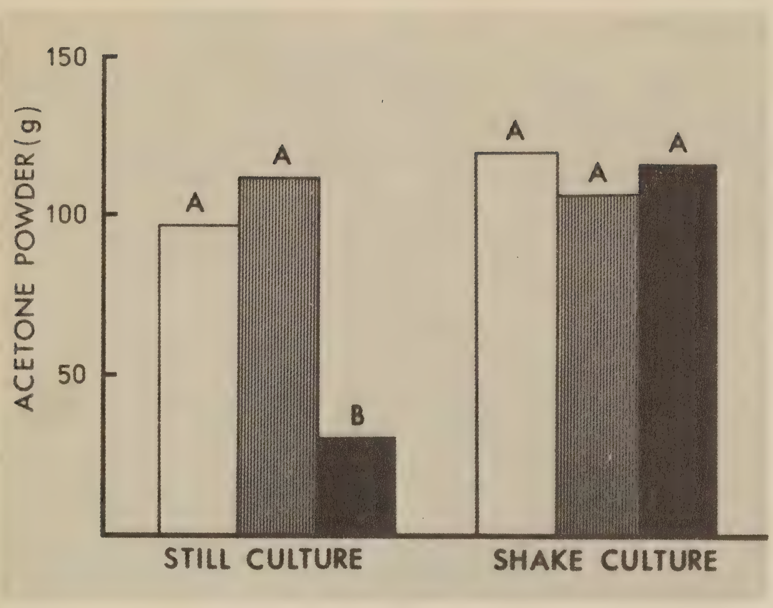

Fig. 1. Mean weight of acetone powder collected from isolates of *C. ulmi*. Values with different letters are significantly different ($P < 0.005$). □ : aggressive; ▥ : intermediate; ■ : non-aggressive.

Protein content

In still culture, the protein content of the non-aggressive isolates was 4 times higher than in the aggressive and intermediate ones (Fig. 2). Incubation on the rotary shaker resulted in a sharp decrease of the protein content of non-aggressive isolates which then exhibited values comparable to the ones observed for aggressive and intermediate isolates. Once again, isolate SSM could not be differentiated from aggressive isolates.

Isoenzymes

The enzyme systems which were electrophoretically analysed are listed in Table 1. The zymograms of alcohol dehydrogenase, peroxidase, polyphenoloxidase and esterase allowed the differentiation of aggressive from non-aggressive isolates grown either in still or in shake culture. Hexokinase could also be used to separate the isolates, but only when they had been grown under still conditions. Malate dehydrogenase showed individual rather than group variations, whereas the banding pattern of phosphoglucomutase was the same for all isolates. Isolate SSM, which we had termed as intermediate, could not be distinguished from the aggressive isolates, except when the samples had been grown in shake culture and assayed for hexokinase.

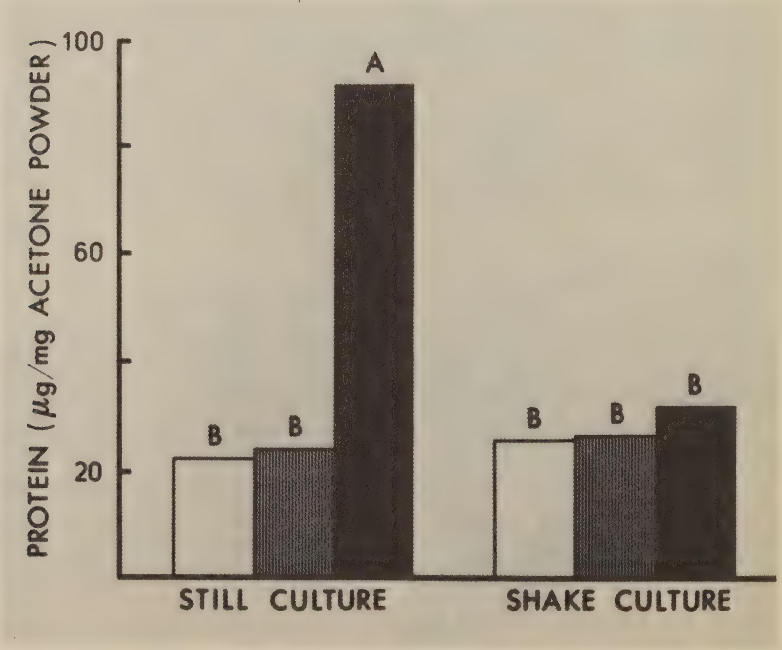

Fig. 2. Mean protein content of isolates of Ceratocystis ulmi. Values with different letters are significantly different ($P < 0.005$). □ : aggressive; ▥ : intermediate; ■ : non-aggressive.

Table 1. Separation of isolates of C. ulmi into groups according to isoenzyme patterns.

Enzyme assayed	Mode of incubation of the fungus	
	Still culture	Shake culture
Alcohol dehydrogenase	AG[a], I /[b]NAG	AG, I /NAG
Malate dehydrogenase	Individual variations	Individual variations
Peroxidase	AG, I / NAG	AG, I / NAG
Polyphenoloxidase	AG, I / NAG	AG, I / NAG
Esterase	AG, I / NAG	AG, I / NAG
Hexokinase	AG, I / NAG	AG, NAG / I
Phosphoglucomutase	No variation	No variation

[a] AG: aggressive; I: intermediate; NAG: non-aggressive

[b] Groups distinguished by this method are separated by solidi

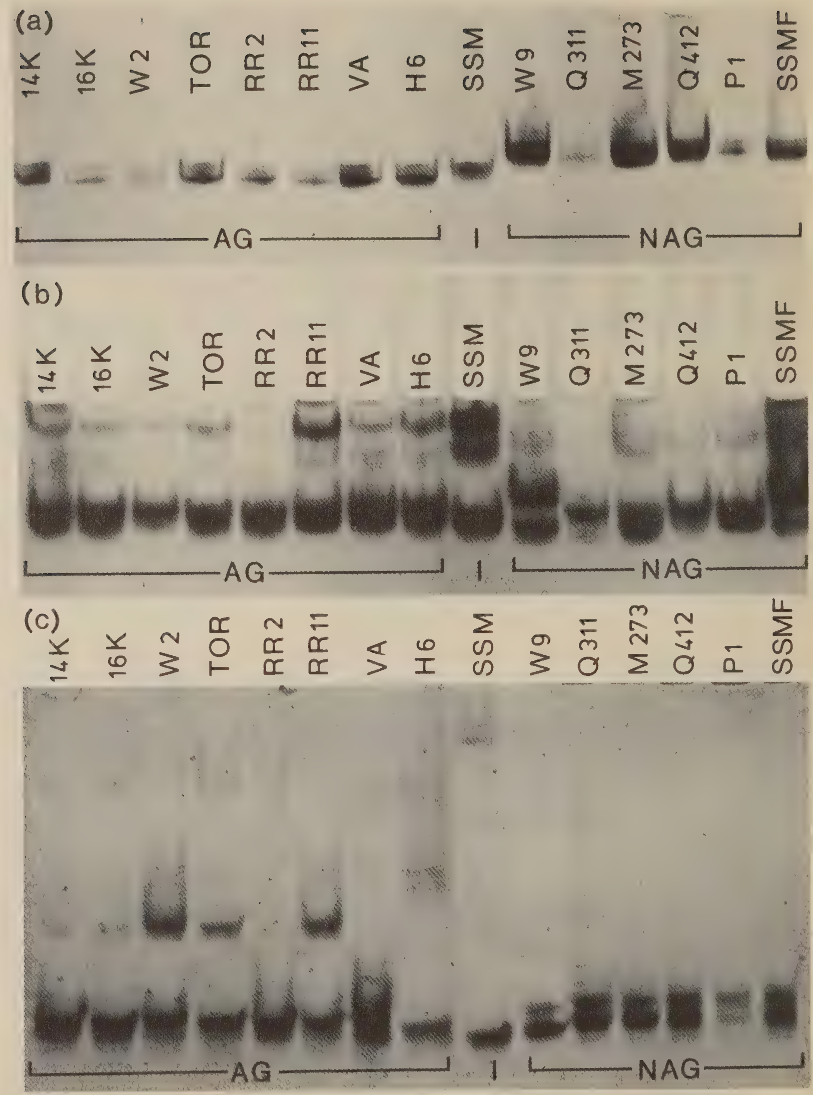
(a)
14K
16K
W2
TOR
RR2
RR11
VA
H6
SSM
W9
Q311
M273
Q412
P1
SSMF
AG
I
NAG
(b)
14K
16K
W2
TOR
RR2
RR11
VA
H6
SSM
W9
Q311
M273
Q412
P1
SSMF
AG
I
NAG
(c)
14K
16K
W2
TOR
RR2
RR11
VA
H6
SSM
W9
Q311
M273
Q412
P1
SSMF
AG
I
NAG

Fig. 3. Isoenzyme patterns for the 15 isolates of *Ceratocystis ulmi*. (a) Alcohol dehydrogenase. (b) Peroxidase. (c) Esterase. The isolates were grown in shake culture (a,b) or in still culture (c). Ag: aggressive; I: intermediate; NAG: non-aggressive.

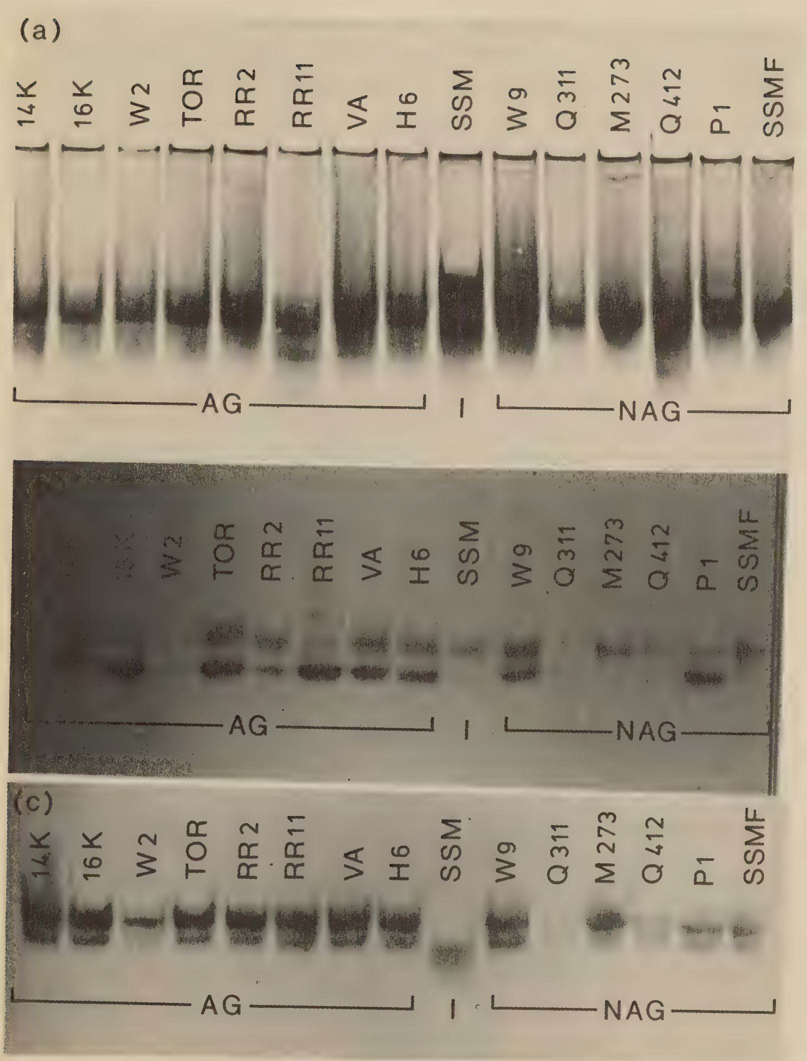
(a)
14K
16K
W2
TOR
RR2
RR11
VA
H6
SSM
W9
Q311
M273
Q412
P1
SSMF
AG
I
NAG
W2
TOR
RR2
RR11
VA
H6
SSM
W9
Q311
M273
Q412
P1
SSMF
AG
I
NAG
(c)
14K
16K
W2
TOR
RR2
RR11
VA
H6
SSM
W9
Q311
M273
Q412
P1
SSMF
AG
I
NAG

Fig. 4. Isoenzyme patterns for the 15 isolates of Ceratocystis ulmi. (a) Malate dehydrogenase. (b) Phosphoglucomutase. (c) Hexokinase. The isolates were grown in shake culture. Ag: aggressive; I: intermediate; NAG: non-aggressive.

Fig. 3a illustrates the zymogram of alcohol dehydrogenase. Non-aggressive isolates can be differentiated from other isolates by their bands of slower electrophoretic mobility. Banding patterns of peroxidase (Fig. 3b) and polyphenoloxidase appeared similar to each other. The aggressive and intermediate isolates had a band of low mobility, very close to the origin, which was not visible in the non-aggressive isolates. This band was particularly strong in isolate SSM. The pattern of the lower bands was variable and suggested individual differences.

The zymogram of esterase is seen in Fig. 3c. In non-aggressive isolates, two dark brown bands (α-esterase) were observed at Rf values of 0.58 and 0.62, while in the other isolates only the lower band was present. A pink band (β-esterase) was also observed in aggressive isolates at Rf 0.47, or 0.57 (isolate VA), and in isolate SSM at Rf 0.11.

The banding patterns of malate dehydrogenase (Fig. 4a) did not allow us to separate the isolates into groups. Apparently, this enzyme is characterized by a high degree of polymorphism which cannot be correlated with aggressiveness. Zymograms of phosphoglucomutase (Fig. 4b) could not be correlated with aggressiveness either: all isolates shared the same bands and only enzyme activity, as indicated by band intensity, differed from one sample to the other. In isolates grown in shake culture and assayed for hexokinase (Fig. 4c), only isolate SSM could be separated from the others.

DISCUSSION

Isoenzyme analysis has become increasingly popular in fungal taxonomy during the last 15 years. Most studies, however, have been conducted at the genus or species level, and authors have generally observed greater variations between than among species or genera (Snider, 1973; Burdon and Marshall, 1981). Stipes (1970) reported similar results after he analysed mycelial protein and enzyme patterns of 13 isolates from 4 species of *Ceratocystis*, among which was *C. ulmi*. He observed no differences in the banding pattern of alkaline phosphatase in the 4 isolates of *C. ulmi* he investigated.

Our data, based on the analysis of 7 enzyme systems in 15 isolates collected from various locations, indicate that isoenzymes can indeed be used as biochemical markers of aggressiveness of *C. ulmi* isolates. Our experience suggests that alcohol dehydrogenase, peroxidase and esterase are the easiest systems to be used for diagnosis, independently of how the isolates were grown (in still or shake culture). The repeatability of the results supports the evidence that this method is highly reliable.

Some authors (Schreiber and Townsend, 1976; Fleming, 1980) have reported difficulties in correlating aggressiveness and cultural characteristics such as growth rate and colony morphology. We encountered a similar problem when we analysed additional samples provided by Dr. G.B. Ouellette. The aggressiveness of these samples was not known to us at the time. Isoenzyme patterns of alcohol dehydrogenase and esterase, however, allowed us to correctly assign the isolates to the aggressive and non-aggressive groups. This "blind" analysis was repeated with isolates supplied by Dr. C.M. Brasier, with similar success (Bernier, 1982; unpublished data). Only one sample, which behaved abnormally during the protein extraction procedure, could not be characterized and it appeared that it had been kept in culture for nearly 7 years (Ouellette, 1982; personal communication). This isolate had likely degenerated during that period of time.

Electrophoretic studies, as well as data on protein content and acetone powder yield, suggest that isolate SSM, which we had at first considered to be intermediate, is quite similar to aggressive isolates. Brasier (1981; personal communication) had already proposed that this culture was a degenerate form of an aggressive isolate. Further studies on more wild isolates are needed to verify this assumption.

A few years after Gibbs and Brasier (1973) reported the occurrence of aggressive and non-aggressive strains of C. ulmi, Brasier (1979) suggested that the aggressive strains could be further separated in two distinct geographic races: North American and Eurasian. There would therefore be at least three genetically distinct groups within the species. In our work, we were interested in investigating differences between aggressive and non-aggressive isolates and so far, results from electrophoretic analyses have not suggested any clear evidence of a subdivision within the groups, although individual variations were recorded for some enzyme systems, notably malate dehydrogenase and peroxidase. A further investigation of the occurrence of races within the aggressive isolates is planned in a near future.

Despite the fact that the mean values of acetone powder yield and protein content of aggressive and non-aggressive isolates grown in still culture were significantly different, these criteria do not appear to be as reliable as isoenzymes for the assessment of aggressiveness. Large variations were recorded within each group. The yield of acetone powder from isolate CESS 14K (agg.) was comparable to values obtained from non-aggressive isolates, and sample W9 (non-agg.) had a low protein content comparable to the one measured in five of the aggressive isolates. On the other hand, incubation of the samples on the rotary shaker yielded values whose distribution permitted no separation of the isolates. Nevertheless, data on protein content and yield of acetone powder suggest that aggressive and non-aggressive isolates of C. ulmi differ in their metabolism, as proposed by Hubbes and Jeng (1981).

The demonstration of a correlation between aggressiveness and some isoenzyme patterns is a first step leading to a better understanding of the genetic variability of C. ulmi. We are now in the process of using isoenzymes as markers in mating experiments, such as the ones previously conducted by Brasier and Gibbs (1976), which should provide additional information on the genetics of the pathogen.

ACKNOWLEDGEMENTS

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SOME NEW OR INTERESTING HELOTIALES FROM THE EASTERN HIMALAYAS

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SUMMARY

This is the description of ten new species and one new genus of the Helotiales from the Eastern Himalayas. Half of the new species belong to the Leotiaceae, namely Allophylaria montana, Bisporella aescula, Bisporella hypostroma, Crocicreas cremea and Thindiomyces epiphyllus, three to the Hyaloscyphaceae: Hyaloscypha parvula, Hyaloscypha pusilla and Mollisina indica and two to the Dermateaceae: Belonopsis vaginalis and Haglundia lanata. Chlorosplenium chlora (Schw.: Fr.) Curtis in Sprague is recorded for the first time and Lambertella himalayensis Tewari & Pant for the second time from the Indian subcontinent.

ZUSAMMENFASSUNG

Zehn neue Arten und eine neue Gattung der Helotiales aus dem östlichen Himalaya-Gebiet werden beschrieben. Die Hälfte davon gehört zu den Leotiaceae, nämlich Allophylaria montana, Bisporella aescula, Bisporella hypostroma, Crocicreas cremea und Thindiomyces epiphyllus, drei zu den Hyaloscyphaceae: Hyaloscypha parvula, Hyaloscypha pusilla und Mollisina indica und zwei zu den Dermateaceae: Belonopsis vaginalis und Haglundia lanata. Chlorosplenium chlora (Schw.:Fr.) Curtis in Sprague wird zum ersten und Lambertella himalayensis Tewari & Pant zum zweiten Mal für den indischen Subkontinent nachgewiesen.

RESUME

Voici la description de dix nouvelles espèces et d'un nouveau genre trouvés dans le Himalaya oriental. La moitié en fait partie des Leotiaceae, c'est-à-dire Allophylaria montana, Bisporella aescula, Bisporella hypostroma, Crocicreas cremea et Thindiomyces epiphyllus; trois en font partie aux Hyaloscyphaceae: Hyaloscypha parvula, Hyaloscypha pusilla et Mollisina indica et deux aux Dermateaceae: Belonopsis vaginalis et Haglundia lanata. Chlorosplenium chlora (Schw.:Fr.) Curtis dans Sprague est documenté pour la première et Lambertella himalayensis Tewari & Pant pour la deuxième fois dans le sous-continent indien.

During the last 20 years THIND and his students have contributed to our knowledge, with many new findings, on the occurrence and distribution of the Helotiales in different regions of the Himalayas, in India and some adjoining countries.

The present work adds one new genus, 10 new species and one new record to the flora of India and adjacent regions. The descriptions are based on material collected by Raghunandan Sharma in the Eastern Himalayas in 1979 and 1980. The fruitbodies have been described from fresh material, supplemented with dried material. The colour in the dried condition was judged by RAYNER (1970) under a stereomicroscope.

The microanatomy was studied with 10 - 16 µm thick longitudinal sections prepared with a freezing microtome and in part with total preparation slides or squash mounts.

The SEM photographs were taken with a Jeol JSM-T 20. For that purpose air dried apothecia were mounted with double self adhesive tape on an aluminium specimen stub. Subsequently the specimens were provided with an electron-conductive coating by vapor coating of an Au/Pd-alloy.

The light microscope photographs were taken with a ZEISS-Standard WL microscope with a fully automatic microscope camera (MC 63) and high class objectives (Plan-Neofluar, Planapochromat) and by the stereo-microscope DRC with fully automatic camera MC 63.

All the collections cited have been deposited in PAN (Panjab University, Botany Department, Herbarium) and duplicates of some collections have been deposited at Prague (PRM), and in the senior author's personal herbarium, as indicated.

CROCICREAS CREMEA Arendholz & R. Sharma sp. nov.

FIGS. Plate 1: Fig. 1 - 5

Apothecia erumpentes, sparsa, cremea, stipitata, usque ad 2 mm, lata in sicco luteola. Hymenium cupulatum. Excipulum ectalum ex textura oblita, hyphae in gelatina inclusae, excipulum medullatum ex textura intricata; margo dentatus, pilis hyalinis unicellularibusque ad 17 x 3 µm in latere interiore marginis. Asci e uncis nati, 75 - 85 x 7.5 µm, cylindracei-clavati, apex rotundatus, poro jodo non caerulescente. Ascosporae uni- ad triseptatae, hyalinae, cylindraceae-fusiformes, 10 - 17 x 2.5 - 3 µm, extrema acuta, supra biseriatae, infra uniseritae. Paraphyses filiformes, septatae, simplices vel ramosae, ascos superantes usque ad 10 µm, ad 3 µm latae.
Holotypus. - In caulibus emortuis Salviae glutinosae L., Debripani, Darjeeling (occidentalis Benghala), Raghunandan Sharma, August 26, 1980: PAN 17433, in herbario cryptogamarum universitatis Panjab; isotypus in herbario W.R.A. 1982-30.

Apothecia scattered, stipitate, deep cupulate, white to cream coloured, on drying pale luteous to straw, stipe concolorous, up to 2 mm in diam. and 2 mm in total height. Hymenium cream coloured, with reddish tinge, on drying pale luteous, cupulate.

Ectal excipulum of textura oblita, up to 75 µm thick, hyphae ± parallel, up to 2 µm in diam., embedded in a gelatinous matrix. Margin with prominent teeth, on the inner side of the margin with unicellular hyaline hairs, darkly staining in cotton blue, up to 17 x 3 µm, impregnated with polygonal crystals up to 21 x 18 µm, which are birefringent.

Medullary excipulum of textura intricata, up to 45 µm thick, in the form of an inverted cone, thickness of the layer decreasing towards the margin, darkly staining in cotton blue, hyphae slender, hyaline, arranged ± parallel in the inner few layers, up to 3 µm in diam.

Stalk cylindrical, 200 - 250 µm wide, wholly textura intricata, hyphae narrow, hyaline, 1.5 µm in diam.

Asci J-, 8-spored, cylindric-clavate, 75 - 85 x 7.5 µm, apex round, with a stem like base, arising from croziers.

Ascospores hyaline, 1-3-septate, cylindric-fusoid, 10 - 17 x 2.5 - 3 µm, with ends pointed, arranged biseriate above and uniseriate below in the ascus.

Paraphyses filiform, hyaline, branched, septate, up to 3 µm wide at the tips, projecting up to 10 µm beyond the tips of the asci.

Etymology of the specific epithet. - Refers to the colour of the apothecia.

Habitat. - On dead stems of Salvia glutinosa L.
Type locality. - Depripani, Darjeeling (W-Bengal).
Holotype. - Mixed forest, August 26, 1980, Raghunandan Sharma, PAN 17433, isotype in the senior author's personal herbarium (W.R.A. 1982-30).

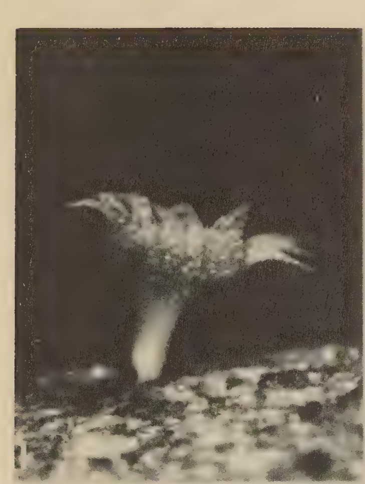
NOTES. - According to CLEMENTS and SHEAR (1931) Crocicreas cremea keys out to Davincia Penz. & Sacc., which was synonymized by KORF (1971, 1973) with Cyathicula de Notaris, which now is considered a taxonomic synonym of Crocicreas Fr. (CARPENTER 1981), a genus which contains most species formerly classified in Phialea, an opinion that is not accepted by SVRCEK (1979).

We subscribe to the conception of CARPENTER (1981) and consider our species as a member of Crocicreas. It resembles somewhat the pantropical Crocicreas helios (Penz. & Sacc.) S.E. Carpenter var. helios S.E. Carpenter, but in that fungus the ascus pore channel is J+ in MELZER's reagent, the asci and the ascospores are somewhat larger (95 - 100 x

Plate 1

CROCICREAS CREMEA Arendholz et R. Sharma sp.nov.; PAN 17433

Fig. 1: Apothecium showing the dentate margin and the crystals in the excipulum; 51 x.
Fig. 2: Fig. 4: Longitudinal section through an apothecium; showing the margin, the hairs and the crystals on the inner side of the teeth; 450 x, 700 x, respectively.
Fig. 3: Part of a longitudinal section through an apothecium; 180 x.
Fig. 5: Dentate margin seen in the polarizing microscope, showing birefringence of the crystals and of the gelatinous matrix; 1115 x (Photos: W.R. Arendholz).



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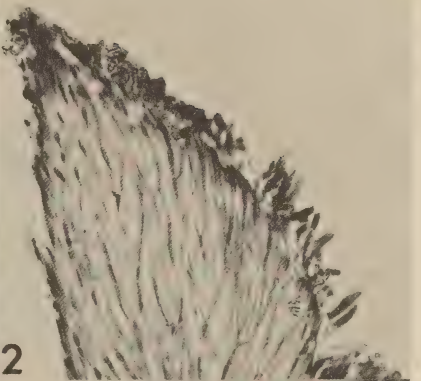

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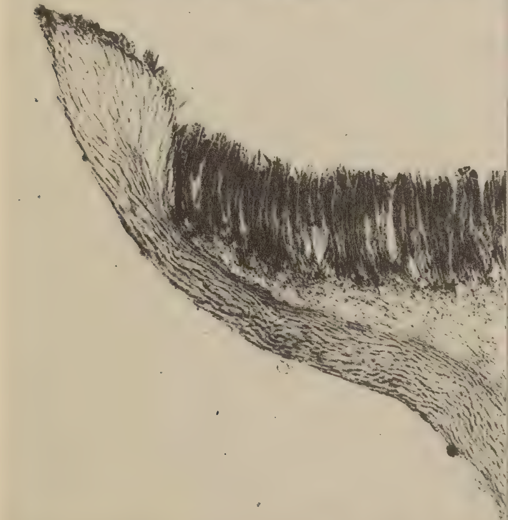

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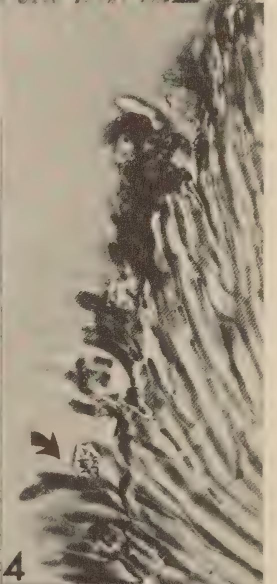

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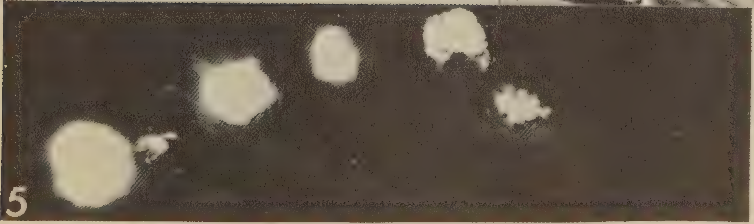

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7 - 8 µm, 15 - 18 x 3 - 4 µm respectively, CARPENTER 1981) and the spore walls are indented at the septa. In Crocicreas helios (Penz. & Sacc.) S.E. Carpenter var. parahelios S.E. Carpenter the ascospore walls are not indented, but the asci and spores are larger, too (95 - 100 x 6 - 7 µm, 22 - 23 - (28) x 2.5 - 3.0 µm respectively; CARPENTER 1981). Crocicreas cremea shows some resemblance to Crocicreas quinqueseptatum S.E. Carpenter likewise, but this species has 5-septate ascospores 30 - 33 x 2.5 - 3.0 µm.

ALLOPHYLARIA MONTANA Arendholz & R. Sharma sp. nov.

FIGS. Plate 2: Fig. 1 - 5

Apothecia gregaria, sessiles, laeves, badia, usque ad 1.5 mm lata. Hymenium cupulatum, brunneum ad badium. Excipulum ectalum ex textura oblita, excipulum medullatum ex textura intricata. Asci e uncis nati, octospori, 150 - 160 x 10 - 12 µm, cylindracei clavati, poro jodo caerulescente. Ascosporae hyalinae, usque ad quadriseptatae, biseriate, 20 - 30 x 3.5 - 5.0 µm, cylindraceae, extrema rotundatae. Paraphyses filiformes, septatae, simplices vel ramosae, ascos superantes usque ad 25 µm, usque ad 3.5 µm latae.
Holotypus. - In trunco putrescenti angiospermo, Dochula (alt. 11000 ft.), Bhutan, September 25, 1980, Raghunandan Sharma, PAN 17569, in herbario Cryptogamarum universitatis Panjab; isotypus in herbario W.R.A. 1982-31.

Apothecia gregarious, sessile, convex, smooth, light brown, up to 1.5 mm in diam., on drying receptacle dilute cinnamon, stipe dilute buff,± translucent, horny.

Plate 2

ALLOPHYLARIA MONTANA Arendholz et R. Sharma sp. nov.; PAN 17569

Fig. 1: Longitudinal section through an apothecium; 70 x.
Fig. 2: Apothecium seen under the stereomicroscope, side view; 31 x.
Fig. 3: Three apothecia seen under the stereomicroscope, seen from above; 21 x.
Fig. 4: Longitudinal section through an apothecium showing margin and some spores; 1115 x.
Fig. 5: Longitudinal section through an apothecium showing parts of the ectal and medullary excipulum; 700 x. (photos: W.R. Arendholz).

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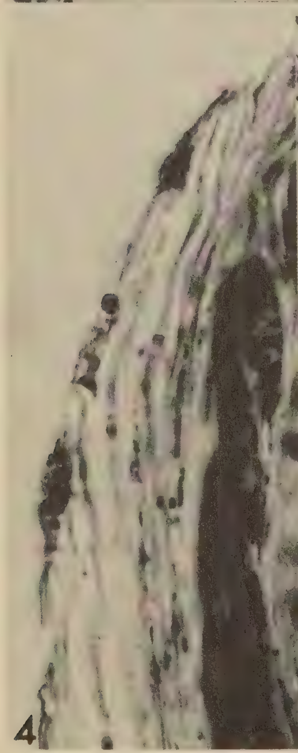

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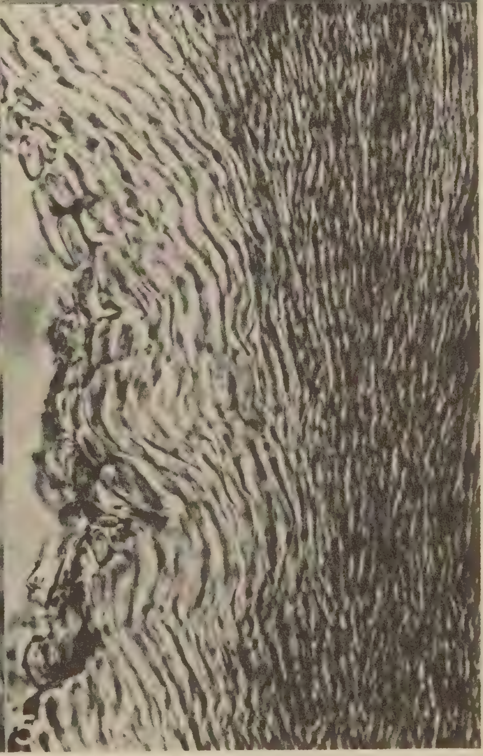

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Hymenium flat, light brown, on drying turning shallow, cupulate, reddish brown.

Ectal excipulum textura porrecta, up to 75 µm thick, cells up to 40 x 4 µm, cell walls glassy, hyphae embedded in a gelatinous matrix and arranged parallel to the surface of the apothecium, outermost cells slightly protruding outwards. Medullary excipulum of textura intricata to textura porrecta, up to 210 µm thick, hyphae compactly arranged, up to 3.5 µm in diam.

Asci J+, 8-spored, 150 - 160 x 9 - 11 µm, cylindrical-clavate, apex round, stalk long, stem like, arising from croziers. Ascospores hyaline, cylindrical, ends round, up to 4-septate, biseriately arranged in the upper part of the ascus.

Paraphyses hyaline, filiform, septate, branched, not swollen at the tips, up to 3.5 µm in diam., projecting up to 25 µm beyond the tips of the asci.

Paraphyses filiform, septate, branched, up to 2.0 µm in diam.

Etymology of the specific epithet. - Refers to the locality, where the specimen was collected.

Habitat. - On dead twigs of Aesculus indica.
Type locality. - 4 kms towards Tura Peak (Meghalaya).
Holotype. - Angiospermous forest, with long grass, October 6, 1979, Raghunandan Sharma, PAN 17354. Isotype at Prague (PRM) and in the senior author's personal herbarium (W.R.A. 1982-31).

NOTES. - This species fits well into the genus Allophylaria, as typified by NANNFELDT (1932) with Peziza sublicoides Karst., which the senior author had the opportunity to study. In spite of the different substrates (stems of Artemisia, angiospermic log, respectively) the apothecia of Allophylaria sublicoides and A. montana have an ectal excipulum of long-celled, narrow and thick-walled, hyaline hyphae, which do not ramify, but occasionally one can observe anastomoses.

The ascospores are relatively large (A. sublicoides; KARSTEN (1869): 15 - 26 x 6 - 7 µm; DENNIS (1956): 17 - 26 x 6 - 7 µm; A. montana: 20 - 30 x 3.5 µm) and septate (A. sublicoides, DENNIS (1956): "becoming 3-septate"; whereas the senior author only found nonseptate spores in the type specimen of Peziza sublicoides, A. montana rarely 3- to 4-septate).

Allophylaria montana is the second species of Allophylaria known from the Indian subcontinent (cfr. THIND & H. SINGH 1970) and does not resemble any known species of this genus.

BISPORELLA AESCULA Arendholz & R. Sharma sp. nov.

FIGS. Plate 3: Fig. 1 - 5

Apothecia erumpentes, gregaria, aurantiaca, laeves, usque ad 2.5 mm lata et 1.0 mm alta, stipitata, stipes luteolus, ad basim atra; in sicco receptaculum armeniacum ad electrinum, stipes stramineus ad luteolus, ad basim fuscus ad fusconiger. Hymenium planum, aurantiacum. Excipulum ectalum ex textura intricata, parietibus cellulae pachydermis; excipulum medullatum ex textura intricata, hyphae similis excipuli ectali, sed angustiores. Asci e uncis nati, octospori, 90 - 110 x 6.5 - 7.5 µm, cylindracei, poro jodo caerulescente. Ascosporae hyalinae, continuae, 19 - 22 x 2 - 3.0 µm cylindraceae-fusiformes, extrema acutae. Paraphyses filiformes, septatae, simplices vel ramosae, ad 2 µm latae. Holotypus. - In ramunculis emortuis Aesculi indica (Wall. ex Camb.) Hk.f. 4 kms versus Tura Peak (Meghalaya), October 6, 1979, Raghunandan Sharma, PAN 17354, in herbario cryptogamarum universitatis Panjab. Isotypus Pragae (PRM), et in herbario W.R.A. 1980-32.

Apothecia greagarious, flat, 2.5 mm wide and 1 mm in total height, stalked, base black, cup orange coloured and stalk pale yellow, smooth; on drying receptacle dilute apricot-amber, stipe straw to pale yellow, base of the stipe fuscous to fuscous black.

Hymenium flat, orange.

Ectal excipulum of textura intricata to textura porrecta, hyphae thick-walled, somewhat undulating and ± parallel to the surface of the apothecium, cells of the hyphae 7 - 20 x 2 - 2.5 µm.

Medullary excipulum of similar hyphae, but of textura intricata and narrower than the hyphae of the ectal excipulum, somewhat anastomosing.

Asci J+, 8-spored, 90 - 110 x 6.5 - 7.5 µm, cylindrical with a stem like base, arising from croziers.

Ascospores hyaline, cylindric fusoid, pointed at both ends, but narrower in the middle, 12 - 22 x 2 - 3.0 µm, irregulary biseriate.

Paraphyses filiform, sometimes branched, up to 2 µm in diam.

Etymology of the specific epithet. - Refers to the substrate on which the specimen was collected.

Habitat. - Dead and decaying angiospermic log.
Type locality. - Dochula (11000 ft. alt.), Bhutan.
Holotype. - Mixed forest, Raghunandan Sharma, September 25, 1980, PAN 17569. Isotypes at Prague (PRM) and in the senior author's personal herbarium (W.R.A. 1982-31).

NOTES. - At first sight the gross morphology of this species reminds one of a HYMENOSCYPHUS, but the glassy and thick-walled somewhat undulating hyphae of the ectal excipulum do not allow a classification in this genus.

The substrate (angiospermic log) and the microanatomy strongly suggest a relationship to BISPORELLA as typified by Bisporella pallescens (Pers.) Carp. & Korf by KORF and CARPENTER (1974). This species does not resemble any other known species of Bisporella and is the third record of a member of this genus for the Indian subcontinent (cfr. also THIND & S. SAINI, 1967, SHARMA, R. & KORF 1982).

BISPORELLA HYPOSTROMA Arendholz & R. Sharma sp. nov.

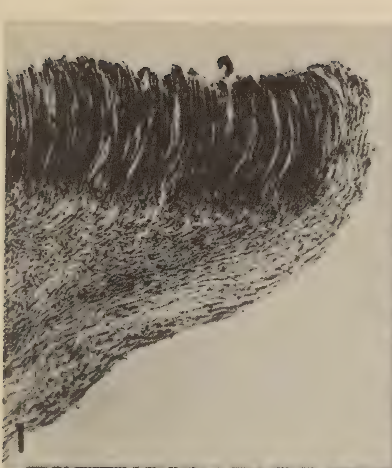
FIGS. Plate 4: Fig. 1 - 4

Apothecia erumpentes e basi plusminusve nigra stromatoidea, sparsa vel gregaria, usque ad 1 mm lata, breves stipitata, cremea ad atrocinnabarina; in sicco basis castanea ad fusca, receptaculum fulvum ad ochraceum versus marginem luteolum ad stramineum. Hymenium planum, in sicco cupulatum. Excipulum ectalum ex textura porrecta ad textura intricata, hyphae in gelatina inclusae, leptodermae; excipulum medullatum ex textura porrecta ad textura intricata, hyphae hyalinae, leptodermae. Asci e uncis nati, octospori, 55 - 90

Plate 3

BISPORELLA AESCULA Arendholz et R.Sharma sp.nov.; PAN 17354

Fig. 1: Longitudinal section through part of an apothecium; 180 x.
Fig. 2: Two apothecia seen under the stereomicroscope; 21x.
Fig. 3: Longitudinal section through an apothecium showing Part of the ectal excipulum; 700 x.
Fig. 4: ditto, showing part of the margin; 1115 x.
Fig. 5: ditto, showing part of the medullary excipulum, 700 x. (photos: W.R. Arendholz).



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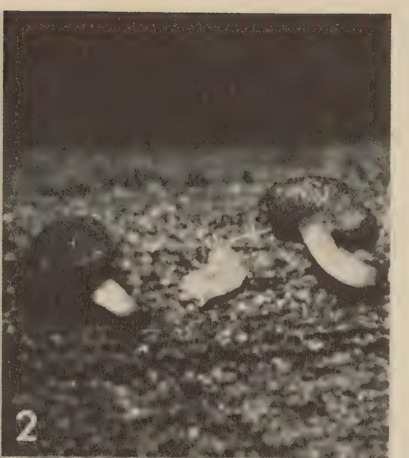

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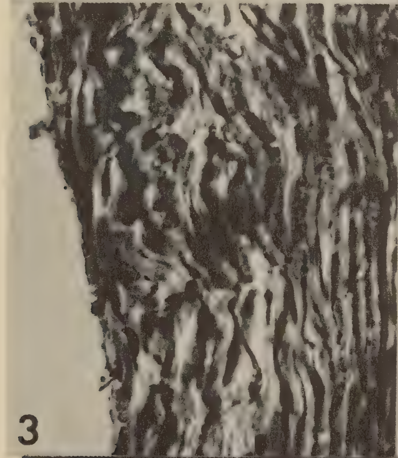

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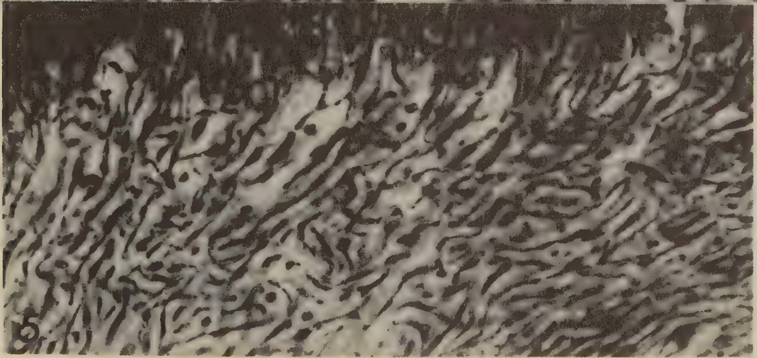

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x 4 µm, cylindracei-clavati, poro jodo caerulescente. Ascosporae hyalinae, continuae, biguttulatae, ellipsoideae ad cylindriceae, 5.5 - 7.5 x 2 - 3 µm, uniseriatae vel irregulariter biseriatae. Paraphyses filiformes, simplices, septatae, ascos superantes ad 8 - 10 µm.
Holotypus. - In rhizomae emortuae Pteridii, Singhik (Sikkim), September 13, 1980, Raghunandan Sharma, PAN 17504; in herbario cryptogamarum universitatis Panjab; isotypus in herbario W.R.A. 1982/33.

Apothecia erumpent from a ± black stromatic base, scattered or gregarious, short stalked, cream to dark red throughout, up to 1 mm in diam. and 2.0 mm in total height; on drying base chestnut to fuscous, receptaculum dilute fulvous ochraceous, luteous to straw, towards the margin pale.

Hymenium plane, on drying cupulate.

Ectal excipulum of textura porrecta to textura intricata, hyphae embedded in a gelatinous matrix, up to 20 µm thick, cells of the hyphae small up to 10.5 x 3.5 µm, hyaline, thin-walled.

Medullary excipulum of textura porrecta to textura intricata, up to 75 µm thick, hyphae hyaline, thin-walled, up to 1 µm in diam.

Asci J+, 8-spored, 54 - 90 x 4 µm, cylindric-clavate, arising from croziers.

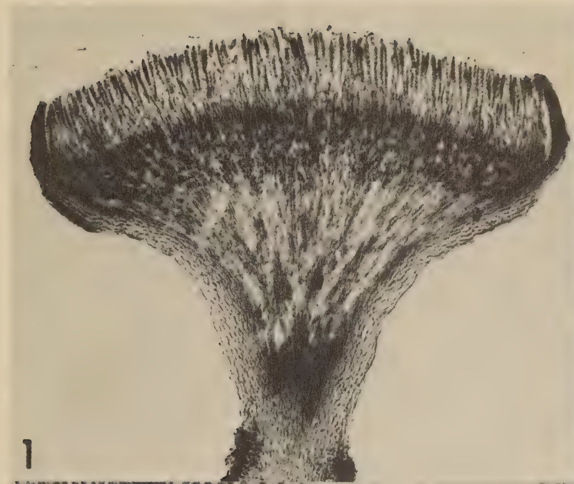
Ascospores hyaline, biguttulate, elliptic-cylindric, 5.5 - 7.5 x 2 - 3 µm, uniseriate to irregularly biseriate, ascospores occupying the upper half of the ascus.

Paraphyses filiform, septate, unbranched, 1.5 - 2.0 µm wide, projecting up to 8 - 10 µm beyond the tips of the asci.

Plate 4

BISPORELLA HYPOSTROMA Arendholz et R. Sharma sp.nov.;
PAN 17504

Fig. 1: Longitudinal section through an apothecium; 180 x.
Fig. 2: Two apothecia seen under the stereomicroscope; 21 x.
Fig. 3: Longitudinal section through an apothecium, base of the stipe; 700 x.
Fig. 4: Longitudinal section through an apothecium showing part of the ectal excipulum; 700 x.
(Photos: W.R. Arendholz)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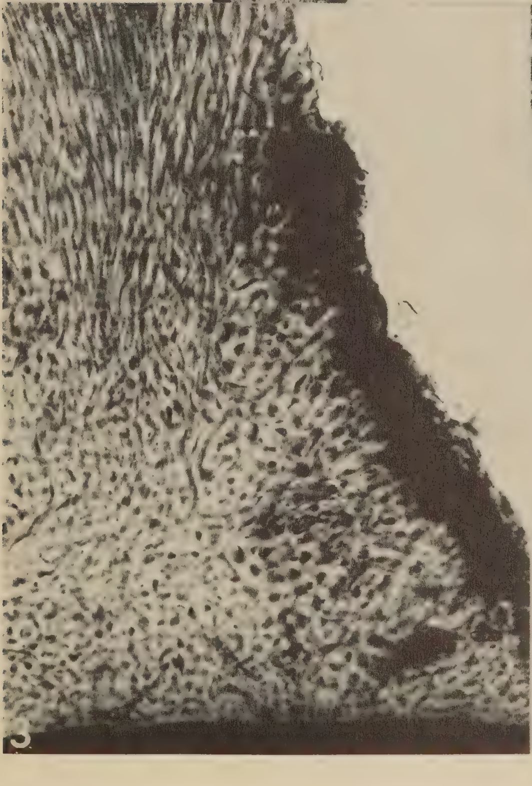
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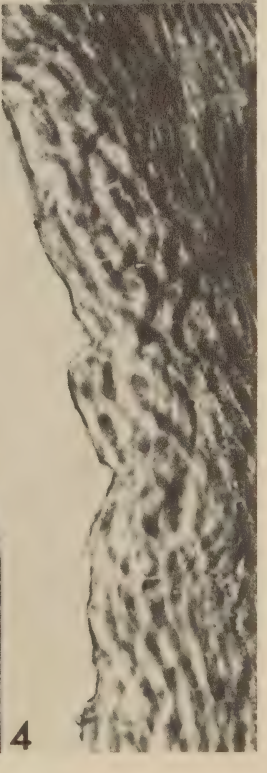
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Etymology of the specific epithet. - Refers to the stromatic base, from which the apothecia arise.

Habitat. - On dead rhizomes of Pteridium sp.
Type locality. - Singhik (Sikkim).
Holotype. - Angiospermous forest, September 13, 1980, Raghunandan Sharma, PAN 17504, isotype in the senior author's personal herbarium, W.R.A. 1982-33.

NOTES. - The apothecia of Bisporella hypostroma originate from a (?) stromatic base, which in dry condition closely resembles the dark coloured substrate, but it is not a sclerotium in the sense of the Sclerotiniaceae nor there are rind cells of a substratal stroma as in Lambertella or Poculum. In Calycella oedema (Desm.) v. Höhnel (= Pezizella sclerotinioides Rehm) growing on leaves of Rosa and Rubus we find the same structure, which v. HÖHNEL (1918) called a "Hypostroma". Type specimens of Calycella oedema and Pezizella sclerotinioides were studied by the senior author in an earlier study (cfr. ARENDHOLZ 1979, p. 26). In these the hyphae of the ectal excipulum are rather thick-walled, embedded in a gelatinous matrix and somewhat undulating. These characters would fit well in the generic concept of Bisporella, but we defer from making the necessary new combination until the senior author has finished his monographic studies of Pezizella, for there are some hints that Pezizella and Bisporella are synonyms, of which Pezizella is the older name and has priority.

Bisporella hypostroma is the fourth record of a member of this genus for the Indian subcontinent (cfr. p. 466).

THINDIOMYCES Arendholz & R. Sharma gen. nov.

Genus familiae Leotiaceae (Helotiales), apotheciis minutis, brevis stipitatis, pilis brevibus, irregulariter ramosis, cylindraceis, non granulosis, multicellularibus, hyalinis, paraphysibus, filiformibus, septatis, apice obtusis nec ascos superantibus. Asci e uncis nati, cylindracei-clavati, octospori, poro jodo caerulescente.
Species typica generis: *Thindiomyces epiphyllus Arendholz & R. Sharma.*
Etymology of the generic name. - In honour to Prof. K.S. Thind, Panjab University, Chandigarh, India.

THINDIOMYCES EPIPHYLLUS Arendholz & R. Sharma gen. et sp. nov.

FIGS. Plate 5: Fig. 1 - 6

Apothecia erumpentes, sparsa vel gregaria, breviter stipitata, cremea, usque ad 1 mm lata, in sicco bubalina ad mellea, angulata; extus minute puberula, pili breves, ad 25 x 2 - 3 µm, irregulariter ramosi, cylindracei, non granulosi, multicellulares, hyalini. Hymenium profunde cupulatum, cremea. Excipulum ectalum ex textura prismatica, parietibus cellularum pachydermis; excipulum medullatum ex textura porrecta vel textura intricata. Asci octospori, cylindracei-clavati, e uncis nati, 30 - 45 x 3.5 µm, poro jodo caerulescente. Ascosporae hyalinae, continuae, 3.5 - 5.5 x 1 µm, fusiformes, oblique uniseriatae. Paraphyses septatae, cylindraceae , obtusae, usque ad 2 µm latae, ascos leviter superantes.
Holotypus. - In superficiebus ambabus emortui folii angiospermi. Nawephu (BHUTAN), September 26, 1980, Raghunandan Sharma, PAN 17589, in herbario cryptogamarum universitatis Panjab; isotypus in herbario W.R.A. 1982-34.

Apothecia gregarious to scattered, erumpent, short-stalked, up to 1 mm in diam., cream coloured, on drying buff to honey, apothecia becoming angular; receptacle hairy, hairs septate, short, up to 25 x 2 - 3 µm, irregularly branched, hyaline, cylindrical.

Hymenium deep cupulate, deep yellow, on drying cream-coloured; margin incurved.

Ectal excipulum of textura prismatica, hyaline, glassy, up to 20 µm thick, cells thick-walled, 8 x 6 µm, becoming more elongated and incurved near the margin.

Medullary excipulum of textura porrecta, to textura intricata, 20 µm thick, hyphae ± thick-walled, 3 µm in diam.; hypothecium indistinct.

Asci J+, 8-spored, cylindric clavate, 30 - 45 x 3.5 µm, arising from croziers.

Ascospores hyaline, fusiform, 3.5 - 5.5 x 1 µm, obliquely uniseriate, nonseptate.

Paraphyses cylindrical, up to 2 µm wide, apices blunt, slightly longer than the asci.

Etymology of the specific epithet. - Refers to the substrate, on which the specimen was collected.

Habitat. - On both surfaces of dead angiospermic leaves.
Type locality. - Nawephu (Bhutan).
Holotype. - Mixed forest, September 26, 1980, Raghunandan Sharma, PAN 17589; isotype in the senior author's personal herbarium (W.R.A. 1982-34).

NOTES. - Thindiomyces epiphyllus is characterized by the peculiarly branched hairs, which are not known for any other species in the HELOTIALES hitherto, and by the ectal excipulum of textura porrecta of textura prismatica with rather thick-walled hyphae. The possession of characteristic thick-walled hyphae is the reason for classifying Thindiomyces in the LEOTIACEAE rather than in the HYALOSCYPHACEAE.

SVRCEK (1977) described for Dendrotrichoscypha acanthopila somewhat similar, but more irregularly branched hairs, which are reminiscent of dendrocystidia or acanthophyses of the Basidiomycetes. As in Thindiomyces these branches are not septate.

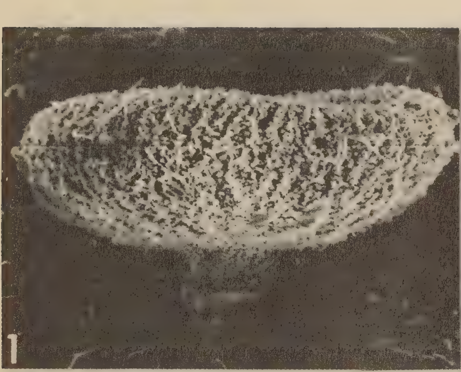
Both hair types could have been a starting-point or intermediate steps in the evolution of the hyphal processes in Mollisina: we have only to imagine that the cell-lumen of the branches will become narrower and narrower - e.g. by replacing of the lumen by secondary wall thickening - until you cannot ascertain any lumen in the "branches" under the light microscope - as in Mollisina. It may be that the hyphal processes have a submicroscopical lumen, but this has to be clarified by the TEM, as pointed out by the senior author (ARENDHOLZ 1979).

Thindiomyces differs from Bisporella in its branched and multiseptate hairs, whereas in Bisporella the hairs are

Plate 5

THINDIOMYCES EPIPHYLLUS Arendholz et R. Sharma gen. et sp. nov.;PAN 17589

Fig. 1: One apothecium showing downy excipulum, SEM-picture; 170 x.
Fig. 2: Apothecium seen under the stereomicroscope; 51 x.
Fig. 3: Longitudinal section through an apothecium; 180 x.
Fig. 4: Longitudinal section through an apothecium showing part of the excipulum and hymenium; 700 x.
Fig. 5: Hairs, SEM-picture; 4000 x.
Fig. 6: Hairs seen under the light microscope, bright field, medium: Lactophenol-Cotton blue; 1115 x.
(photos: W.R. Arendholz)



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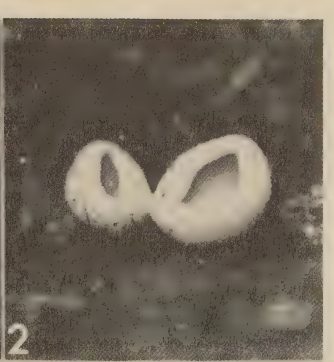

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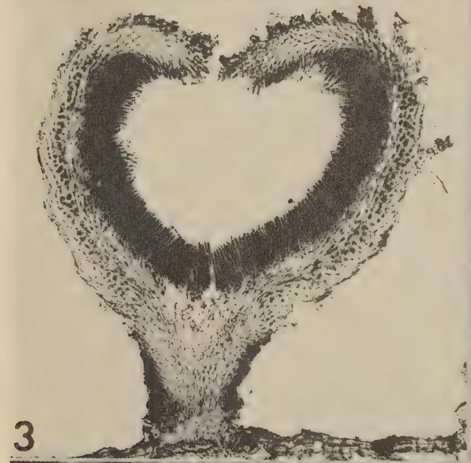

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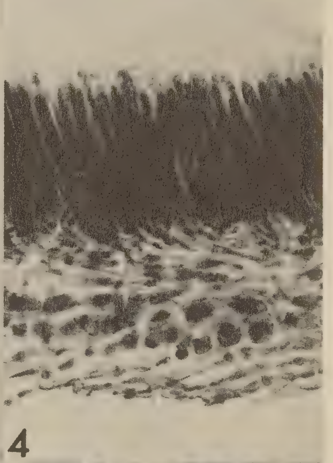

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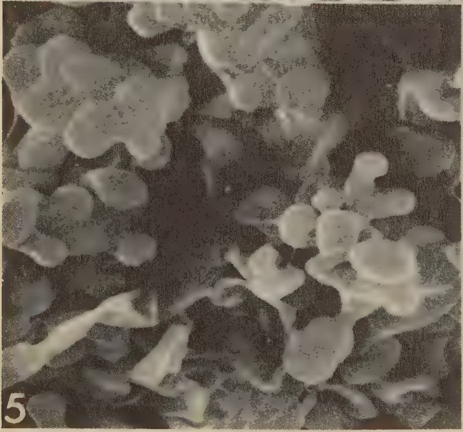

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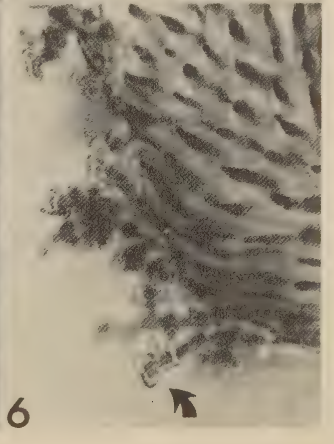

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small and papillate or short cylindric with obtuse tips and one- to two-celled, if present.

Moreover in Thindiomyces in the ectal excipulum the hyphae are arranged ± parallel and are at most inclined at an acute angle to the surface of the apothecium, whereas in Bisporella the hyphae are very unarranged and inclined at a high angle to the surface. Furthermore in Thindiomyces there are present short isodiametric cells staining deeply in cotton blue and/or congored, in the ectal excipulum towards the medullary region.

DASYSCYPHUS BICOLOR (Bull.) Fuck. var. INDICUS Müller & Dennis

FIGS. Plate 6: Fig. 1 - 6

Apothecia scattered, deep seated in the substrate, concave, sessile, up to 1 mm in diam., external surface white, fringed with hairs; hairs cylindrical, septate, tapering to a point, granulated with irregular crystals.

Hymenium ± concave light orange, on drying apricot to orange.

Asci J+, 8-spored, 65 - 85 x 8.5 - 10 µm, clavate-cylindric, apex obtuse, narrow, with a stem like base, arising from croziers.

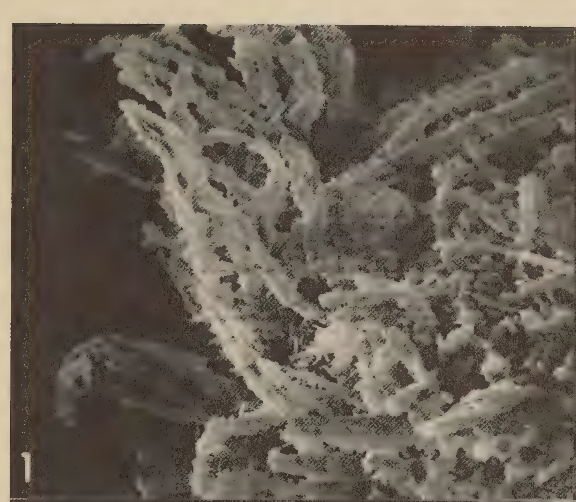
Ascospores hyaline, guttulate, at maturity up to 3-septate, 15 - 22 x 2 - 3 µm, cylindrical straight or curved, ends round, irregularly biseriate.

Paraphyses lanceolate, septate, up to 3 µm wide, projecting beyond the tips of the asci, up to 10 µm.

Plate 6

DASYSCYPHUS BICOLOR (Bull.) Fuck. var. INDICUS Müller & Dennis; PAN 17641

Fig. 1 - 3: Hairs showing crystals at their surfaces, SEM-picture; 810 x, 6100 x, 2900 x, respectively.
Fig. 4: Longitudinal section through an apothecium showing hairs at the margin; 1115 x.
Fig. 5: Longitudinal section through an apothecium showing part of the ectal excipulum and hairs; 1115 x.
Fig. 6: Two apothecia seen under the stereomicroscope; 33 x. (photos: W.R. Arendholz)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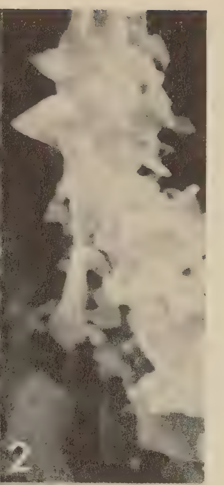
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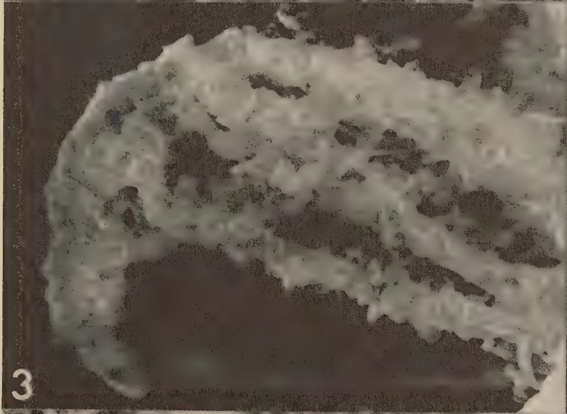
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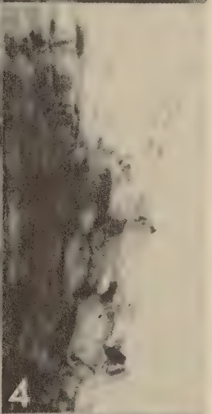
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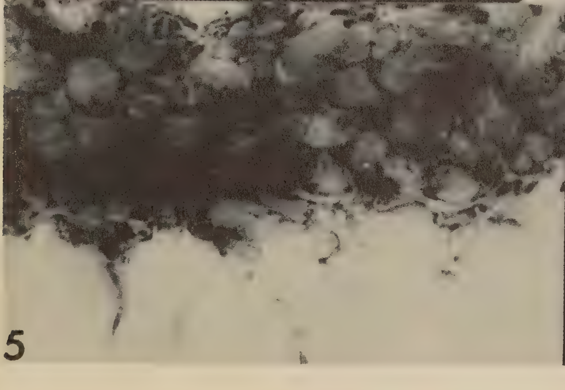
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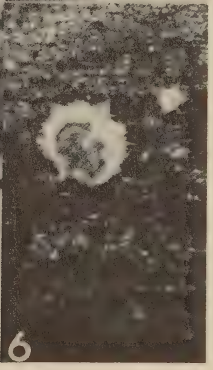
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Ectal excipulum of textura angularis becoming textura prismatica at the margin, cells up to 12 x 5.5 µm.

Medullary excipulum of textura intricata, cells thin-walled, up to 14 x 2 µm.

Habitat. - On dead stems of Salvia glutinosa L.
Specimens examined. - Palmajuha, Darjeeling (W-Bengal) alt. 2400 m, mixed forest, August 30, 1980, Raghunandan Sharma, PAN 17641; part of this collection is also deposited in the senior author's personal herbarium (W.R.A. 1982-39).

NOTES. - Apart from the missing stipe, the ectal excipulum of textura angularis and the different substrate this collection fits well in the variation range of Dasyscyphus bicolor var. indicus (Müller & Dennis 1959), which grows on twigs of Rubus ellipticus Sm. and not on dead leaves of Rubus ellipticus as quoted by H. SING (1975).

If the missing stipe proves to be a constant character, this collection may be worth varietal or species rank.

The scaly structures of the hairs, as revealed by the SEM, seem to be a calcareous lime: Lactic acid reacts with lime and in the mounting medium, AMANN's Lactophenol, after some time the hairs become smooth when studied in the light microscope.

Dasyscyphus bicolor var. indicus resembles Dasyscyphus subcorticalis (Pat.) Dennis, too, which grows on bark (OTANI 1975) or rotting branches (DENNIS 1954, 1970) but has 3-septate ascospores 25 - 30 x 2 - 3 µm.

Dasyscyphus apalus (Berkeley & Broome) Dennis growing on dead culms and leaves of Juncus is also somewhat similar to D. bicolor var. indicus, but has 1-7-septate ascospores 35 - 45 x 1.5 µm (MASSEE 1895, REHM 1896, DENNIS 1949, 1948, RAITVIIR 1970, but PHILLIPS 1887: 15 - 30 x 3 µm).

MOLLISINA INDICA Arendholz & R. Sharma sp. nov.

FIGS. Plate 7: Fig. 1 - 8

Apothecia erumpentes, sparsa vel gregaria, aurantiaca, usque ad 1 mm lata, stipitata, extus minute puberula, in sicco ochracea, stipes luteolus. "Pili" parvi, laeves, 3 x 1 µm, probabaliter protuberationes cellularum. Hymenium cupulatum. Excipulum ectalum ex textura angularis ad textura prismatica, ad 40 µm latum, cellulae ad 7 x 5.5 µm. Excipu-

lum medullatum ex textura intricata. Asci e uncis nati, octospori, 25 - 40 x 3.5 - 4.5 µm cylindracei-clavati, apex rotundatus, poro jodo caeruelscente. Ascosporae hyalinae, continuae, biguttulatae, 3.5 - 5.0 x 1.5 - 2.0 µm, ellipsoideae, obliquae uniseriatae vel irregulariter biseriatae. Paraphyses filiformes, septatae, simplices vel ramosae, longitudine ascorum, usque ad 1.5 µm latae.
Holotypus. - In foliis et culmis emortuis graminis, Batasi (alt. 2250 m) Darjeeling, September 9, 1979, Raghunandan Sharma, in herbario cryptogamarum universitatis Panjab, PAN 17257 A; isotypus in herbario W.R.A. 1982-35.

Apothecia gregarious to scattered, cupulate to plane, smooth, light orange, turning deep cupulate, bright orange, up to 1 mm in diam. and up to 1 mm in total height, on drying ochraceous to pale ochraceous, stipe pale luteous.

Hymenium cupulate, concolorous with the receptacle.

Ectal excipulum of textura angularis with a tendency to become textura prismatica, up to 40 µm thick, cells up to 7 x 5.5 µm, becoming smaller and narrower toward the margin.

Medullary excipulum of textura intricata, up to 45 µm thick, hyphae thin-walled, compactly arranged, up to 3 µm in diam.

Asci J+, 8-spored, 27 - 37 x 3.5 - 4.5 µm, cylindric-clavate, apex round, tapering to a flat base, arising from croziers.

Ascospores hyaline, biguttulate, 3.5 - 4 x 1.5 - 2.0 µm, ellipsoid, obliquely uniseriate to irregularly biseriate.

Paraphyses filiform, branched, septate, uniform in width throughout their length, up to 1.5 µm wide, slightly projecting beyond the tips of the asci.

"Hairs": The outermost cells of the ectal excipulum are drawn out into papilla like structures, the cells with the "hairs" up to 10 x 4.5 µm; "hairs" (hyphal "processes") up to 3 x 1 µm, smooth.

Etymology of the specific epithet. - Refers to the locality, where the specimen was collected.

Habitat. - On dead fallen leaves and culms of some grass.
Type locality. - Batasi (alt. 2550 m), Darjeeling, W-Bengal.
Holotype. - Mixed forest, September 9, 1979, Raghunandan Sharma, PAN 17257 A, isotype in the senior author's personal herbarium (W.R.A. 1982-35).

NOTES. - Mollisina indica is the first species of Mollisina known from India. Thus this genus does not seem confined to Europe (4 species, cfr. ARENDHOLZ 1979) and the U.S.A. (CASH 1958, one species, unknown to the senior author - Mollisina ammophilae Cash) but covers a greater region. Moreover the number of the species which belong to Mollisina appears to be much larger than so far presumed, for the senior author ascertained at least four new - as yet unpublished - Mollisina species during his work at a revision of Pezizella Fuckel.

Mollisina indica does not resemble any known species of Mollisina previously studied by the senior author.

HYALOSCYPHA PARVULA Arendholz & R. Sharma sp. nov.

FIGS. Plate 8: Fig. 1 - 6

Apothecia gregaria, parva, superficialia, cupulata, subglobescentes, alba basi fusca, ad 0.15 mm lata, extus pilosa, pili hyalini, laeves, basibus leviter bulbosis, apices acuti, flagelliformes ad unciformes, ad 30 - 40 x 2.5 - 4.5 µm. Hymenium concolorum receptaculo, planum vel leviter cupulalum. Excipulum ectalum ex textura prismatica ad textura angularis, excipulum medullatum ex textura angularis. Asci octospori, e uncis nati, 30 - 45 x 5.5 - 6.5 µm, clavati, apex rotundatus, poro jodo caerulescente. Ascosporae hyalinae, bi- ad triguttulatae, usque ad maturitatem evanescentes, allantoideae, 5.5 - 11.5 x 1.5 - 2.5 µm, irregulariter biseriatae.

Plate 7

MOLLISINA INDICA Arendholz et R. Sharma sp. nov.;
PAN 17257 A

Fig. 1: Longitudinal section through an apothecium; 180 x.
Fig. 2; Fig. 3: Hairs on the excipulum, SEM-pictures; 6100x, 2900 x, respectively.
Fig. 4: Apothecium seen under the stereomicroscope; 33 x.
Fig. 5-7: Longitudinal section through an apothecium showing the lumen of the branched "hairs"
Fig. 5: Differential interference contrast; 1115x
Fig. 6: Phase contrast; 1115 x
Fig. 7: Bright field; 1115 x.
Fig. 8: Longitudinal section through an apothecium showing part of the excipulum, differential interference contrast; 700 x. (photos: W.R. Arendholz)

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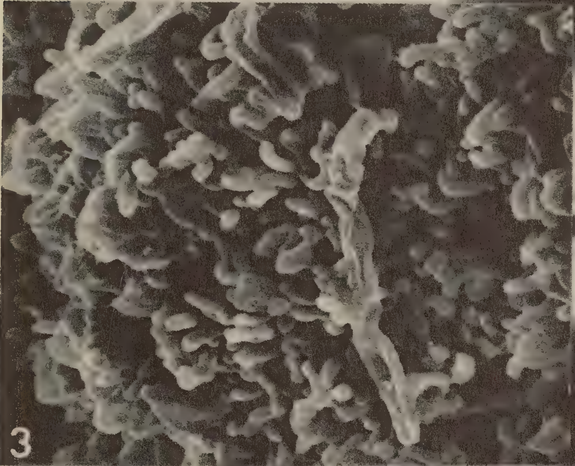
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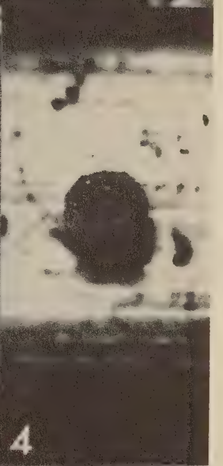
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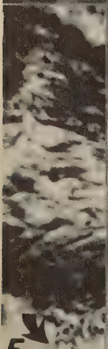
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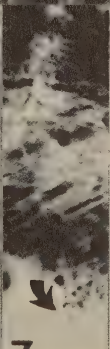
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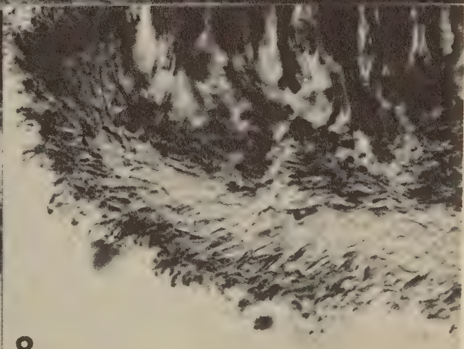
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Paraphyses filiformes, ramosae, hyalinae, nonseptatae (?), ad 1.5 µm latae, ascos leviter superantes.
Holotypus. - In codice arboris indeterminato, 6th mile (alt. 2350 m), Darjeeling, occidentalis Benghala, August 20, 1980, Raghunandan Sharma, PAN 17640 in herbario cryptogamarum universitatis Panjab; isotypus in herbario W.R.A. 1982-36.

Apothecia gregarious, small, up to 0.15 mm in diam., superficial, cupulate, at later stages becoming subglobose due to the overcrowded shaggy hairs, white, with pale tinge, on drying buff, base black; hairs hyaline, smooth with a slightly bulbous base, apex long, pointed, whip like to hook like, up to 30 - 40 x 2.5 - 4.5 µm.

Ectal excipulum of textura prismatica to textura angularis, hyphae thin-walled, cells up to 12 x 4.5 µm, im MELZER's reagent walls with a slight brownish tinge; medullary excipulum of textura angularis.

Asci J+, 8-spored, clavate, 30 - 45 x 5.5 - 6.5 µm, apex round, stalk short, arising from croziers.

Ascospores hyaline, 2-3-guttulate, guttules disappearing at maturity, allantoid, 5.5 - 11.5 x 1.5 - 2.5 µm, irregularly biseriate in the ascus.

Paraphyses filiform, branched, hyaline, narrow, nonseptate (?), up to 1.5 µm in diam., projecting slightly beyond the tips of the asci.

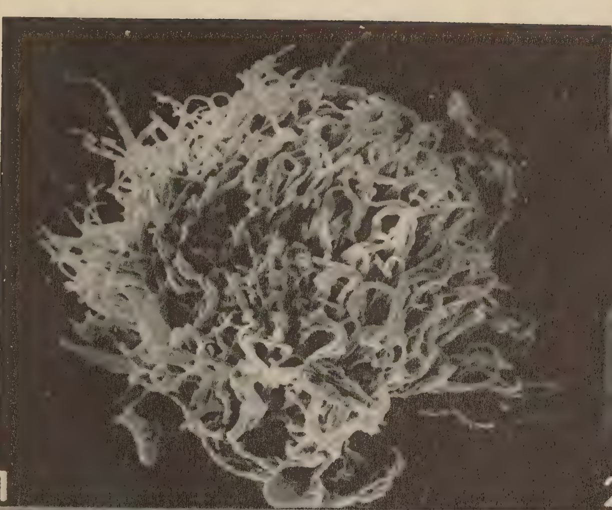
Etymology of the specific epithet. - Refers to the small size of the apothecia.

Habitat. - On dead stump of unidentified stem.
Type locality. - 6th mile (alt. 2350).
Holotype. - Angiospermous forest, Darjeeling (W-Bengal), August 20, 1980, Raghunandan Sharma, PAN 17640; isotype in

Plate 8

HYALOSCYPHA PARVULA Arendholz et R. Sharma sp.nov.;
PAN 17640

Fig. 1: An apothecium, SEM-picture; 600 x.
Fig. 2: A single hair, SEM-picture; 4000 x.
Fig. 3: Excipulum with hairs, SEM-picture; 1300 x.
Fig. 4: Hairs seen in the light microscope, bright field, medium: MELZER's reagent; 450 x.
Fig. 5: Longitudinal section through an apothecium; 450 x.
Fig. 6: Hairs seen in the polarizing microscope; 450 x.
(photos: W.R. Arendholz)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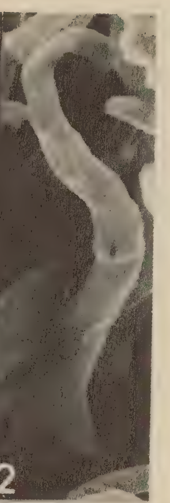
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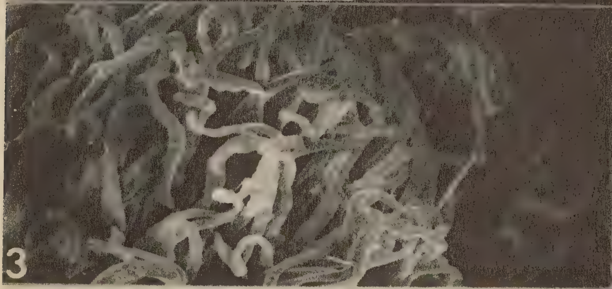
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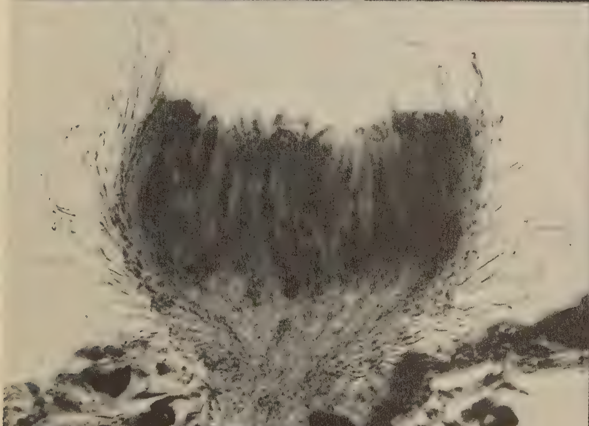
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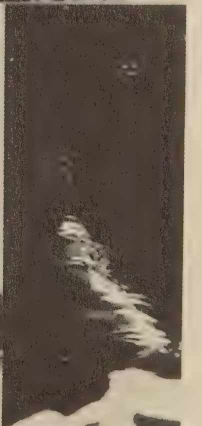
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the senior author's personal herbarium (W.R.A. 1982-36).

NOTES. - Hyaloscypha parvula resembles Hyaloscypha hyalina forma 4 (DENNIS 1949) in ascus and ascospore measurements, but it differs from it in the smaller apothecia and in the strongly curved hairs. These thin-walled, non-glassy hairs are dextrinoid and show clearly birefringence in the polarizing microscope. Both hairs characters are unusual in typical Hyaloscyphas as in H. hyalina and its relatives, but they are typical of some Hyaloscyphaceae with glassy hairs (RASCHLE, 1977; KORF et KOHN, 1980) such as Hyalopeziza, Unguiculella etc.

According to KORF et KOHN (1980) this species would key out to Hyalopeziza subg. Hyalopeziza, but typical Hyalopeziza species as typified by Hyalopeziza ciliata Fuckel have straight, thick-walled hairs (cfr. also RASCHLE 1978). Thus on account of the hair characters (hairs thin-walled, with a lumen up to the apex, walls dextrinoid), Hyaloscypha parvula seems somewhat intermediate between Hyaloscypha and Hyalopeziza subg. Hyalopeziza. Hyal. parvula also resembles Hyaloscypha cincinnata Sherwood (SHERWOOD 1974) in having allantoid but larger ascospores. The hairs in H. cincinnata have a bulbous base and a curly apex. The reaction in MELZER's reagent is unknown.

HYALOSCYPHA PUSILLA Arendholz & R. Sharma sp. nov.

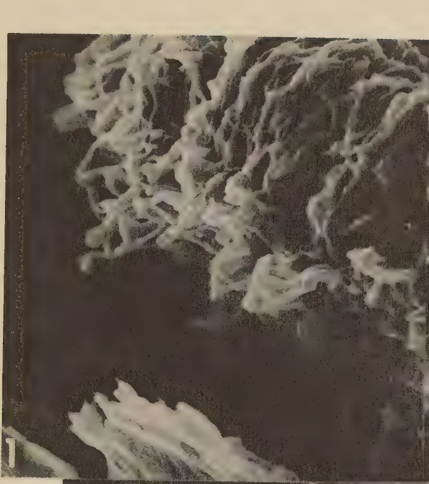
FIGS. Plate 9: Fig. 1 - 6; Plate 10: Fig. 4

Apothecia sessiles, superficialia, gregaria usque ad terna aggregata, in sicco albida vel dilute ochracea, margine albo, 0.2 - 0.3 mm lata, extus plusminusve pubescentes, pili breves, 15 - 20 x 1.5 - 2.0 µm, basi tumida, contracti aequaliter obtusum punctum. Hymenium planum, plusminusve

Plate 9

HYALOSCYPHA PUSILLA Arendholz et R. Sharma sp. nov.;
PAN 17257

Fig. 1: Excipulum with hairs, SEM-picture; 1300 x.
Fig. 2: A single hair (arrow), SEM-picture; 3900 x.
Fig. 3: Part of an apothecium, excipulum; 610 x.
Fig. 4-5: Apothecia seen under the stereomicroscope, from above, side view, respectively; 51 x.
Fig. 6: A total preparation slide showing hairs, bright field; 700 x. (photos: W.R. Arendholz)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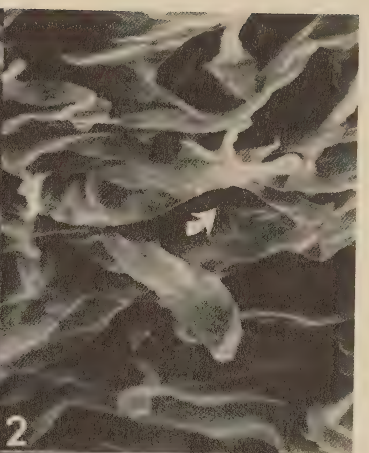
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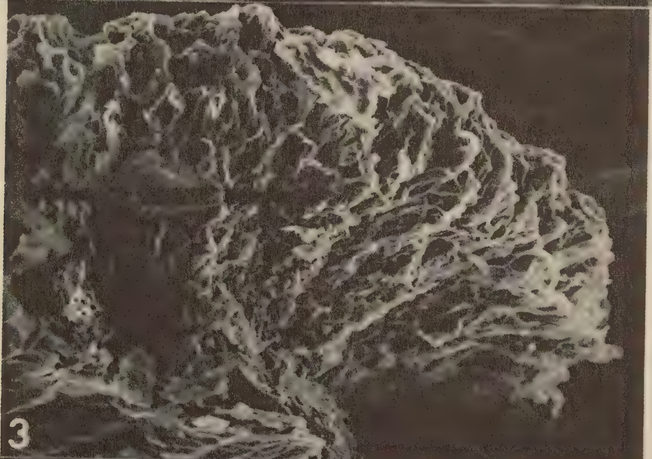
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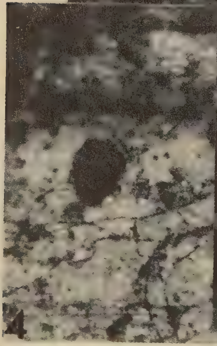
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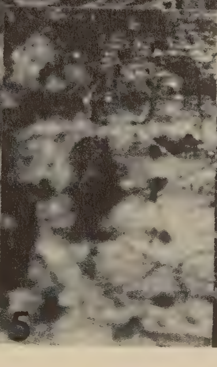
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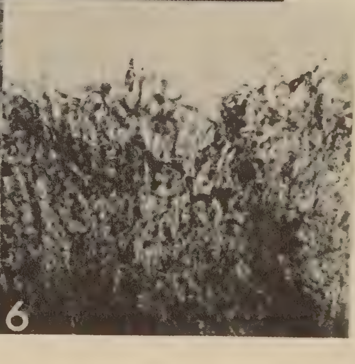
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album. Excipulum ectalum ex textura prismatica, excipulum medullatum ex textura intricata, cellulae leptodermae. Asci e uncis nati (?), octospori, clavati, 23 - 28 x 4 - 5 µm. Ascosporae hyalinae, continuae, ellipsoideae, guttulatae, 5.5 - 6.5 x 1.5 - 2.0 µm, irregulariter biseriatae. Paraphyses filiformes, septatae, ascos leviter superantes. Holotypus. - In gramine emortuo, Batasi, occidentalis Benghala, alt. 2250 m, September 9, 1979, Raghunandan Sharma, PAN 17257, in herbario cryptogamarum universitatis Panjab; isotypus in herbario W.R.A. 1982-37.

Apothecia sessile or with a short stalk-like base, scattered or in groups of three, on drying whitish or dilute ochraceous, margin white, receptacle ± downy; hairs short, 15 - 20 x 1.5 - 2 µm, one-celled, with a swollen base and tapering evenly to a blunt point.

Ectal excipulum of textura prismatica, medullary excipulum of textura intricata, hyphae thin-walled.

Asci 8-spored, J-, clavate, 23 - 28 x 4 - 5 µm, arising from croziers (?).

Ascospores hyaline, one-celled, ellipsoid, with two large and several small oil-drops, 5.5 - 6.5 x 1.5 - 2 µm, irregularly biseriate.

Paraphyses filiform, septate, 1.5 µm wide, slightly projecting beyond the tips of the asci.

Etymology of the specific epithet. - Refers to the small size of the apothecia.

Habitat. - On dead fallen grass.
Type locality. - Batasi, W-Bengal, alt. 2250 m.
Holotype. - On dead fallen grass leaves, September 9, 1979, Raghunandan Sharma, PAN 17257; isotype in the senior author's personal herbarium (W.R.A. 1982-37).

NOTES. - The hairs with the bulbous base and the straightly drawn out apices are the most striking character of Hyaloscypha pusilla. These hairs, which are not numerous and are easily overlooked in the light-microscope, class this specimen with Hyaloscypha. Strange to say that it is difficult to find these hairs when Hyaloscypha pusilla is studied in the SEM. This difficulty is possibly attributable to the air-dried apothecia and should be clarified by critical-point dried specimens.

Hyaloscypha pusilla differs from Hyaloscypha paludosa Dennis (DENNIS 1962) and Hyaloscypha secalina Vel. (VELENOVSKY, 1934), both growing on rotting grasses and rushes, by its smaller hairs, asci and ascospores, and from Hyaloscypha nympharum Vel. (VELENOVSKY, 1934, on leaves of Iris pseudacorus; CLARK 1980 on leaves of Scirpus silvaticus) by its smaller asci and ascospores and the hairs two-celled at most.

LAMBERTELLA HIMALAYENSIS Tewari & Pant

FIGS. Plate 10: Fig. 1 - 3

Apothecia scattered, stalked, arising from a stromatised base, stalk up to 2 mm long, apothecia up to 3 mm wide, reddish brown, on drying receptacle and stipe fuscous black.

Hymenium cupulate, reddish brown, on drying somewhat dark citrine to isabelline.

Ectal excipulum of textura prismatica, medullary excipulum of textura intricata, hyphae always thin-walled; excipulum turning bluish-green in MELZER's reagent. Cells at the margin extend outwards and downwards.

Asci J+, 4-spored, clavate-cylindric, with a long stalk, 75 - 100 x 7 - 7.5 µm.

Ascospores dark brown, spore wall punctate, broadly ellipsoid with one or both ends pointed, thick-walled with granular contents, guttulate, guttules disappearing at maturity, 14 - 18 x 8 - 10 µm, uniseriately arranged in the ascus.

Paraphyses filiform, slightly projecting beyond the tips of the asci.

Habitat. - On dead fallen twigs of some angiosperm.
Specimens examined. - Angiospermous forest (dominated by Quercus trees), Batasi, Darjeeling (W-Bengal), September 6, 1979, Raghunandan Sharma, PAN 17223; part of this collection is also deposited at PRM, and in the senior author's personal herbarium (W.R.A. 1982-38).

NOTES. - This collection fits very well in the variation range of Lambertella himalayensis Tewari & Pant and is the second record of this species in India, described by TEWARI & PANT (1967).

Some apothecia of this collection are parasitised by a Hyphomycete, which can easily be misinterpreted as additional hymenial elements or outgrowths of the paraphyses.

CHLOROSPLENIUM CHLORA (Schw.:Fr.) Curtis in Sprague

FIGS. Plate 11: Fig. 1 - 5

Apothecia gregarious, sessile, cupulate, somewhat membranous, receptacle greenish black, up to 3 mm in diam.; on drying amber to pale luteous, villose, releasing a yellowish green dye in 2 - 3 % KOH.

Hymenium maize yellow, on drying luteous.

Ectal excipulum of textura angularis, cells rather thick-walled, brown; medullary excipulum of textura intricata, hyphae narrow. Marginal hyphae ("hairs") light green, cylindrical, unbranched, up to 4 septate, measuring up to 100 x 3 - 4 µm.

Asci J+, 45 - 55 x 3 - 4 µm, clavate-cylindric, 8-spored, arising from croziers.

Ascospores hyaline, flat on one side, 5.5 - 7 x 1.5 µm, fusoid.

Paraphyses filiform, branched, 1.5 - 2 µm wide.

Habitat. - On dead and decaying log of some angiosperm. Specimens examined. - Angiospermous forest, Mawphlang, Shillong (Meghalaya), September 24, 1979, PAN 17322; this specimen is also deposited at PRM and in the senior author's personal herbarium (W.R.A. 1982-40). Isotype of Peziza crocitincta Berk. & Curt., Georgia, Ravanel No. 1730, CUP-A 1730.

NOTES. - This collection is the first record of Chlorosplenium chlora from the Indian subcontinent. It is identi-

Plate 10

LAMBERTELLA HIMALAYENSIS Tewari et Pant; PAN 17223

Fig. 1: An apothecium, as seen under the stereomicroscope; 33 x.
Fig. 2: Longitudinal section through an apothecium showing part of the ectal excipulum; 700 x.
Fig. 3: Longitudinal section through an apothecium, showing stipe; 180 x.

HYALOSCYPHA PUSILLA Arendholz et R. Sharma sp. nov.; PAN 17257

Fig. 4: One apothecium, SEM-picture; 400 x.
(photos: W.R. Arendholz)

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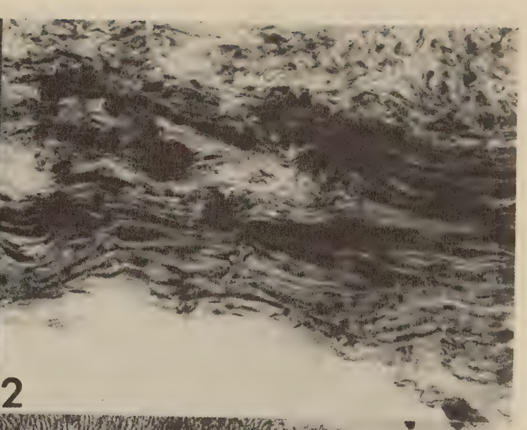

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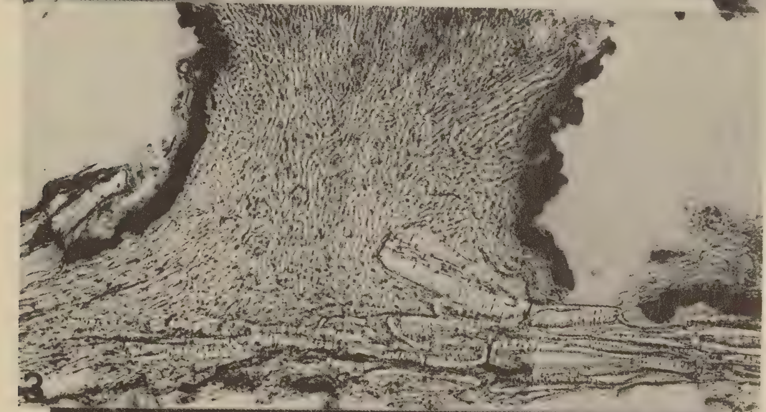

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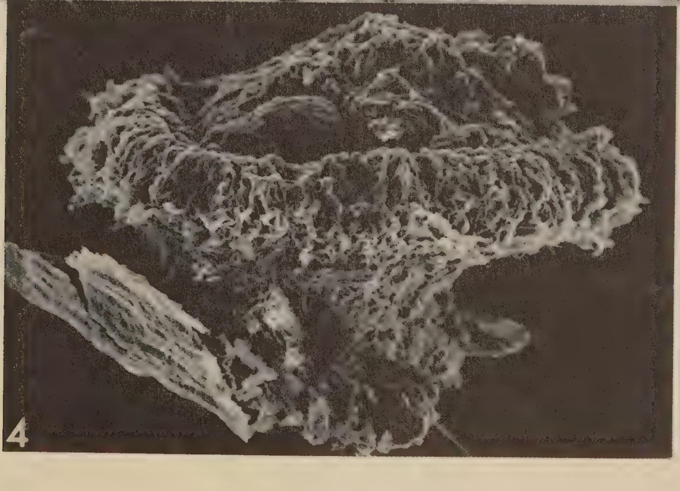

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cal with the type material of Peziza crocitincta Berk. & Curtis, which is a taxonomic synonym of Chlorosplenium chlora according to DIXON (1974) and which was studied by the senior author within the scope of a revision of Pezizella Fuckel.

Both specimens release a yellowish green colouring matter in 2 - 3 % KOH, a reaction which is not mentioned by DIXON (1974).

HAGLUNDIA LANATA Arendholz & R. Sharma sp. nov.

FIGS. Plate 12: Fig. 1 - 3, plate 13, Fig. 3, 5

Apothecia gregaria, stipitata, cupulata, grisea, in sicco glauca, usque ad 1 mm lata; margo et receptaculum plusminusve pilosus, pili ad marginem bi- ad quinqueseptati, apice rotundati, ad 55 x 2 µm, in microscopio composito laeves. Hymenium cupulatum, sordidum flavum, in sicco melleum. Excipulum ectalum ex textura intricata, versus marginem textura porrecta, hyphae aliquantum pachydermae, excipulum medullatum ex textura intricata. Asci e uncis nati, octospori, cylindracei-clavati, 40 - 45 x 5.5 µm, poro jodo caerulescente. Ascosporae hyalinae, fusiformes, 4 x 1.5 µm, irregulariter biseriatae. Paraphyses filiformes, hyalinae, ramosae, septatae, usque ad 2 µm latae.
Holotypus. - Ad corticem emortuam angiospermam, Senchal Lake, Darjeeling, occidentalis Benghala, August 19, 1979, Raghunandan Sharma, PAN 17101, in herbario cryptogamarum universitatis Panjab; isotypus in herbario W.R.A. 1982-41.

Apothecia gregarious, stalked, cupulate, pastel-grey, on drying glaucous, rehydrated ± black with a fringe of grey hairs, up to 1 mm in diam., margin and receptacle ± hairy,

Plate 11

CHLOROSPLENIUM CHLORA (Schw.:Fr.) Curtis in Sprague;
PAN 17322

Fig. 1: One apothecium, SEM-picture; 81 x.
Fig. 2: Part of the excipulum showing hairs, SEM-picture; 1250 x.
Fig. 3: Apothecium as seen under the stereomicroscope; 33 x.
Fig. 4: Longitudinal section through an apothecium showing part of the ectal excipulum; 1115 x.
Fig. 5: Longitudinal section through one half of an apothecium; 70 x. (photos: W.R. Arendholz)

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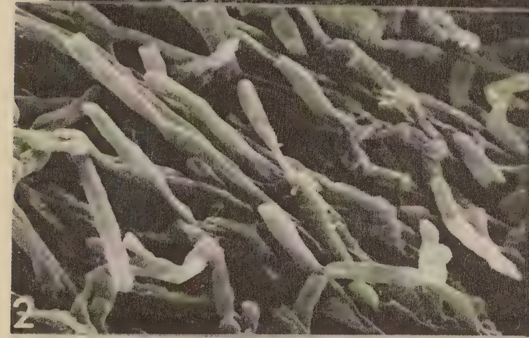

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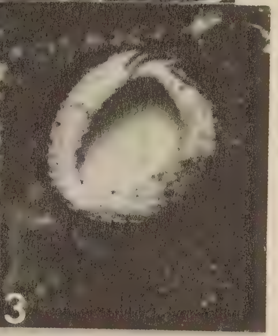

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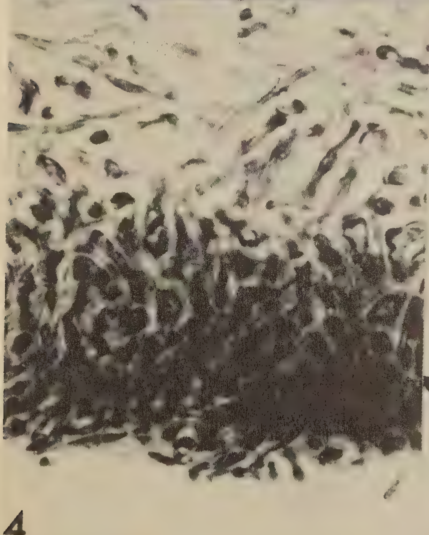

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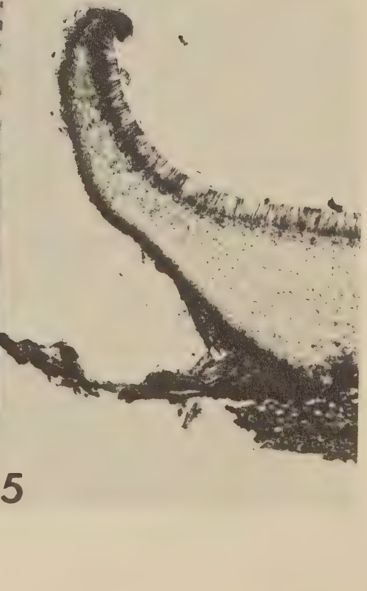

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hairs at the margin 2-5-septate, apex round, smooth when studied in the light microscope, in the SEM with a woolly incrustation, up to 55 x 2 µm.

Hymenium cupulate, dirty yellow, on drying ± honey. Ectal excipulum of textura intricata, towards the margin of textura porrecta, hyphae somewhat thick-walled, at a high angle to the surface of the apothecia.

Medullary excipulum of textura intricata, hyphae thin-walled and narrow.

Asci J+, 8-spored, cylindric-clavate, 40 - 45 x 5.5 µm, arising from croziers.

Ascospores hyaline, fusoid, 4 x 1.5 µm, irregularly biseriate in the ascus.

Paraphyses filiform, branched, septate, hyaline, up to 2 µm in diam.

Etymology of the specific epithet. - Refers to the woolly incrustation of the hairs, revealed by the SEM.

Habitat. - On dead angiospermic bark.
Type locality. - Senchal Lake, Darjeeling (W-Bengal)
Holotype. - Angiospermous forest, August 19, 1979, Raghunandan Sharma, PAN 17101; isotypes at PRM and in the senior author's personal herbarium (W.R.A. 1982-41).

NOTES. - With some hesitation this species is classified in Haglundia, mainly on account of its septate, greyish hairs at the margin and the dark coloured receptaculum, although the excipulum is not typically mollisioid as described by NANNFELDT (1932) for Haglundia perelegans Nannf., the type species of Haglundia.

Haglundia lanata differs from the type and the remaining species of this genus (H. elegantior Graddon, GRADDON (1967) H. sarmentorum Svrček, SVRCEK (1967); H. magnipilosa Svrček, SVRCEK (1978)) by its short stipe, the smaller asci and ascospores and the different colouring.

Plate 12

HAGLUNDIA LANATA Arendholz et R. Sharma sp. nov.;
PAN 17101

Fig. 1: Hairs with woolly incrustation, SEM-picture; 3850 x.
Fig. 2: Apothecium showing downy excipulum, as seen under the stereomicroscope; 51 x.
Fig. 3: Longitudinal section through an apothecium; 180 x.
(photos: W.R. Arendholz)

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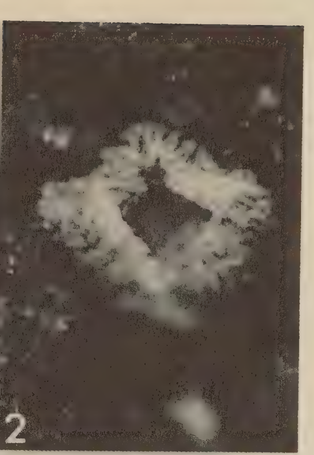
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The hairs of Haglundia lanata are smooth, as studied in the light microscope, but in the SEM the walls of the hairs show a woolly incrustation. Whether the hairs of the remaining species of Haglundia have the same or a similar incrustation is unknown and needs to be clarified by studying these species with the SEM.

BELONOPSIS VAGINALIS Arendholz & R. Sharma, sp. nov.

FIGS. Plate 13: Fig. 1, 2, 4

Apothecia superficialia, sparsa vel gregaria, sessiles, discoidea, laeves, cinerea, usque ad 2,5 mm lata. Hymenium planum. Excipulum ectalum ex textura angularis - textura globulosa, cellulis magnis, parietibus fuscis, excipulum medullatum ex textura intricata. Asci e uncis nati, octospori, cylindracei-clavati, apex rotundatus, 70 - 85 x 6 - 7.5 µm, poro jodo caerulescente. Ascosporae usque ad triseptatae, hyalinae, cylindraceae, leviter curvatae, extrema rotundatae, supra biseriatae infra uniseriatae. Paraphyses filiformes, septatae, simplices, ascos superantes usque ad 10 µm, 1,5 - 2,0 µm latae.
Holotypus: In vaginae folii Palmae, prope Takdeh, Darjeeling (occidentalis Benghala), August 18, 1979, Raghunandan Sharma, PAN 17186. In herbario universitatis Cryptogamarum Panjab; isotypus in herbario W.R.A. 1982-42.

Apothecia gregarious to scattered, sessile, discoid, smooth, gelatinous, up to 2.5 mm in diameter, grey, drying brown-vinaceous to sepia.

Hymenium flat, drying buff to honey.

Ectal excipulum textura angularis to textura globulosa, large, dark brown; medullary excipulum textura intricata, small and hyaline; cells at the margin clavate.

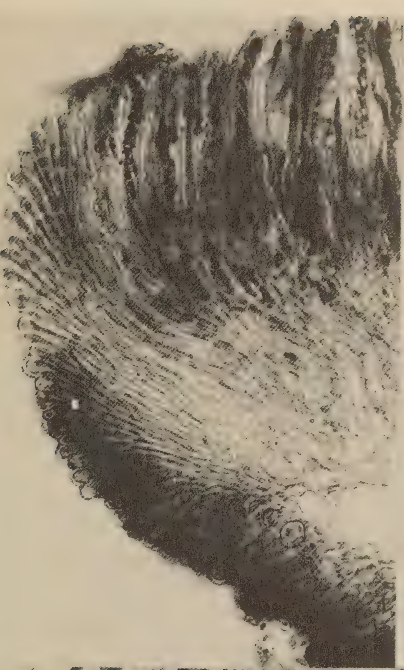
Plate 13

BELONOPSIS VAGINALIS Arendholz & R. Sharma sp. nov.;
PAN 17186

Fig. 1: Longitudinal section through part of an apothecium; 450 x.
Fig. 2: ditto, showing part of the margin; 1115 x.
Fig. 4: One apothecium seen under the stereomicroscope;33 x.

HAGLUNDIA LANATA Arendholz et R. Sharma sp.nov.; PAN 17101

Fig. 3: Fig. 5: Longitudinal section through an apothecium showing parts of the ectal excipulum; 700 x, 450 x respectively. (photos: W.R. Arendholz)



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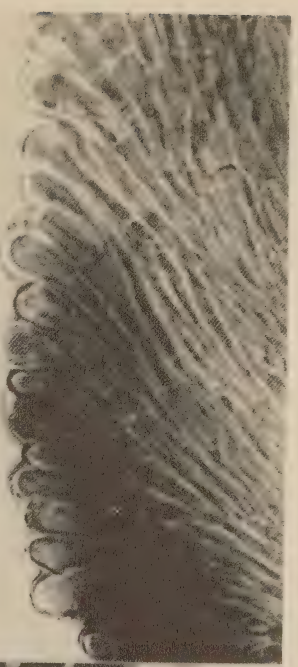

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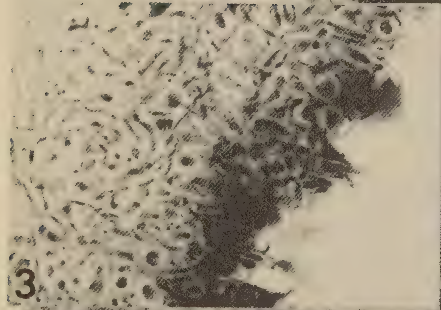

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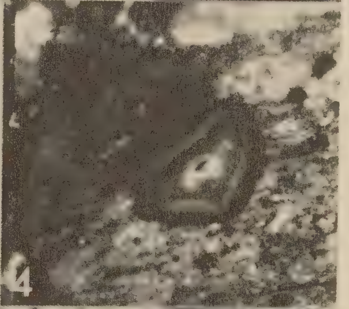

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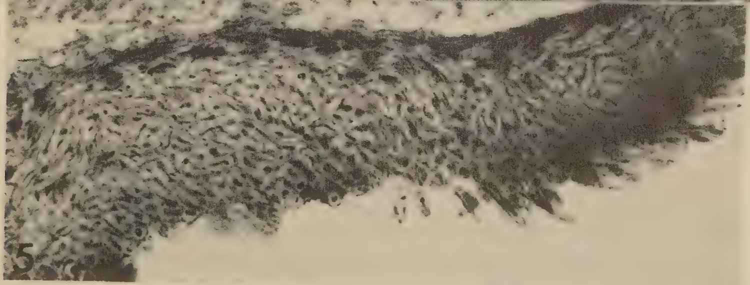

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Asci J+, 8-spored, 80 - 85 x 6 - 7.5 µm, cylindric-clavate, with a short stem like base, apex round.

Ascospores hyaline, cylindric, slightly curved, up to 3-septate, 11,5 - 14 x 2 - 3 µm, with rounded ends, arranged biseriate above and uniseriate in the lower half of the ascus.

Paraphyses filiform, unbranched, septate, projecting 10 µm above the tips of the asci.

Etymology of the specific epithet. - Refers to the substrate, on which it was collected.

Habitat. - Leaf sheaths of some palm trees.
Holotype. - Angiospermous forest, 8 miles towards Takdeh, Darjeeling (W-Bengal), Raghunandan Sharma, August 18, 1979, PAN 17186; isotype in the senior author's personal herbarium (W.R.A. 1982-42).

NOTES. - The above collection differs from Belonopsis filispora (Cke.) Nannf. in that the ascospores are smaller (B. filispora 40 - 45 x 3 - 3.5 µm according to DENNIS 1978) and with both the ends of the spores rounded. Whether Belonopsis vaginalis is classified in Niptera, Mollisia, Tapesia or Belonopsis (= Trichobelonium) (cfr. also DENNIS 1972, 1978; AEBI 1972) is a matter of opinion and the definitive classification has to be deferred until generic limits are better defined; all the fungi of these genera have a mollisioid excipulum of rounded cells with ± thin dark walls and they are somewhat arbitrary distinguishable by a present or absent subiculum and/or one- or two- to many-celled spores.

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ON THE RECENT PROPOSAL TO CONSERVE HYPHODONTIA J. ERIKSS. AGAINST KNIEFFIELLA KARST.

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In a recent survey of temperate wood-inhabiting Aphyllophorales, Jülich and Stalpers (1980) proposed that because of priority, species of Hyphodontia should be transferred to Knieffiella. As a result, numerous new combinations for many species previously placed in Hyphodontia were made.

Later, Eriksson et al. (1982) proposed conservation of Hyphodontia over Knieffiella to preserve the usage that has developed over the last 20-25 years. We strongly support the conservation of Hyphodontia but feel that some strong arguments for such conservation were omitted in the proposal. We feel that consideration of the following information will promote conservation and preserve current usage.

Knieffiella was published by Karsten in 1889 for one species, Hydnum barba-jovis Bull.:Fr. In 1895, Karsten apparently recognized that he had misidentified Bulliard's species and changed the name to Knieffiella bombycina Karst. [=Tomentellina fibrosa (Berk. et Curt.) M. J. Larsen]. Regardless of Karsten's action, Knieffiella remains irrevocably typified by H. barba-jovis Bull.:Fr. In addition, there appear to be problems associated with the historical concept of H. barba-jovis, contrary to the opinions of Eriksson and Ryvarden (1976) and Jülich and Stalpers (1980), who submit that the original concept of Hydnum barba-jobi is well established.

In recognizing Knieffiella, Jülich and Stalpers (1980) presume that what Fries (1821) had in hand (or took from Bulliard, 1791) when he described Hydnum barba-jovis Bull.:Fr. (Bulliard's epithet was barba-jobi) conforms to the current concept of what has been widely named Hyphodontia barba-jovis (Bull.:Fr.) Erikss. If the current interpretation of what Hydnum barba-jovis represents is correct, the action of Jülich and Stalpers is inescapable, except by conserving Hyphodontia against Knieffiella and thus preserving current usage.

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[1] Maintained in cooperation with the University of Wisconsin.

The typification of *Hyphodontia* Erikss. is clear. Eriksson (1958) clearly designated "*Peniophora pallidula* (Bres.) Bres. in B & G" [*Hyphodontia pallidula* (Bres.) Erikss.] as the nomenclatural type of his new genus. He (Eriksson) also transferred "*Hydnum barba-jovis* Sw. ex Fr." to *Hyphodontia*. Bulliard (1791 [1809] and illus. pl. 481, fig. 2) described, as *Hydnum barba-jobi*, a fungus that is effuse, with a toothed hymenophore, having individual teeth with penicillate apices, and becoming rufus straw colored. Fries' (1821) interpretation approximated that of Bulliard, but he changed the epithet to *barba-jovis*. Fries (1836-1838) again treated *H. barba-jovis*, but as a species in *Odontia*. For some obscure reason, two different interpretations of what Fries had in 1821 and in 1836-38 have been taken up by several authors.

The 1821 concept of *H. barba-jobi* was interpreted, and probably correctly so, by Bourdot and Galzin (1924, 1928) as being closely allied to *Acia stenodon* (Pers.) Miller; it was described as "var. 3° *Hydnum barba-jobi* Bull...." In addition, Bourdot and Galzin (1924, 1928) interpreted Fries' (1836-38) description of *H. barba-jovis* as it is currently used, following also the interpretations of Saccardo (1888) and Bresadola (1897, 1903).

The association with *Acia stenodon* (now *Mycoacia*) was also taken up by Nikolaeva (1961). Recognizing the confusion associated with Bulliard's species, she proposed a new name, *Sarcodontia bulliardii* Nikol., for the 1821 interpretation, leaving that of 1836-38 to stand as *H. barba-jovis*. Unfortunately, Nikolaeva's action constitutes the publication of a later synonym. Her name, however, was adopted by Parmasto (1968) and applied to the 1821 interpretation of *H. barba-jovis*. It would have been more appropriate for Nikolaeva to have given a new name to the 1836-38 concept.

Unfortunately, there is no type specimen to solidify Bulliard's and Fries' (1821) concept of *H. barba-jobi*. Bulliard's description and illustration and Fries' descriptions could be interpreted as referring to any of a number of species of *Mycoacia* or *Steccherinum*. Since they indicated that it becomes reddish or orange, there is little reason to believe that a *Hyphodontia* species was necessarily involved in the original concept. Bourdot and Galzin's interpretation seems quite acceptable since *Mycoacia stenodon* (Pers.) Donk and its allies often have an orange cast.

With the above in mind, it appears that Jülich and Stalpers' (1980) action is inappropriate. They have taken as the nomenclatural type of *Kniefffiella* a species name which may well be representative of *Mycoacia* or *Steccherinum*.

In addition, the name *Knieffiella* has been closely associated with the *Thelephoraceae* s. str. due to the introduction of *Knieffiella bombycina*. A similar reference to the *Thelephoraceae* may be inferred from Saccardo (1925), for he likens "*Odontia barba-jovis* Quél." to *Caldesiella ferruginosa* (Fr.) Pat. [=*Tomentella crinalis* (Fr.) M. J. Larsen]. Thus, an additional element of confusion is introduced into an already clouded picture.

Because there are differing interpretations of the protologue resulting in the representation of two different species even as recently as 1961 and 1968, we feel that the most appropriate action is to reject the name H. barba-jovis Bull.:Fr. and its isonyms.

Furthermore, since we conclude that H. barba-jobi does not appear to represent a species of Hyphodontia, the name Knieffia irpicoides Karst. (the next available name) should be used for the fungus previously referred to as Hyphodontia barba-jovis. We propose the new combination: Hyphodontia irpicoides (Karst.) Burdsall et Larsen, comb. nov. (basionym: Knieffia irpicoides Karst., Krit. Öfv. Finl. Basids., p. 368. 1889).

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TWO PERENNIPORIA SPECIES FROM PAKISTAN

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SUMMARY

Perenniporia ahmadii is described as new from Pakistan. *Perenniporia robiniophila* (Murr.) Ryv. comb. nov. is reported from Pakistan and India.

In recent years dr. S. Ahmad, Lahore, Pakistan, has sent me numerous specimens of the Polyporaceae for identification. Among these there were two interesting *Perenniporia* species which are reported here.

PERENNIPORIA ROBINIOPHILA (Murr.) Ryv. comb. nov.
BASIONYM: *Trametes robiniophila* Murr. North Am. Flora 9:42, 1907.

Fruitbody pileate, sessile, single or more often in imbricate clusters with numerous applanate pilei from a common decurrent base, watery and soft when fresh, coriaceous and tough when dry.
Individual pilei 0.5-3 cm thick, up to 15 cm wide and 20 cm long. Pileus white to ochraceous when fresh, pale greyish to unevenly dirty brown on drying, glabrous, slightly sulcate and often with warts and small rounded protuberances. Margin sharp and undulating. Pore surface white when fresh, becoming pale grey to brown when dry. Pores round to angular, 5-6 per mm, sometimes cracked by drying. Tubes concolorous with pore surface and up to 20 mm deep and in dry condition contrasting the white context. Context cottony to corky, white to pale ochraceous, up to 3 cm thick at the base.
Hyphal system dimitic, generative hyphae with clamps, hyaline, 2-4 µm wide, often very difficult to find in dry specimens, skeletal hyphae dominating in trama and context, unbranched or rarely dichotomously branched, thick-walled to solid, 3-10 µm wide and strongly dextrinoid. Basidia not seen, but reported by Overholts (1953:314), 9-12 µm in diameter. A few cystidiols seen, clavate and up to 20 µm long and 3-5 µm in diameter. Spores subglobose to slightly drop-shaped, hyaline, slightly thick-walled and dextrinoid, 5-8(9) x 5-7 µm.
Found on dead and living deciduous trees. Overholts (op. cit.) reports it from *Acer*, *Broussonetia*, *Celtis*, *Liriodendron*, *Morus*, *Paulownia*, *Robinia* and *Quercus* in the United States. The collection from Pakistan was collected on living *Celtis australis*.

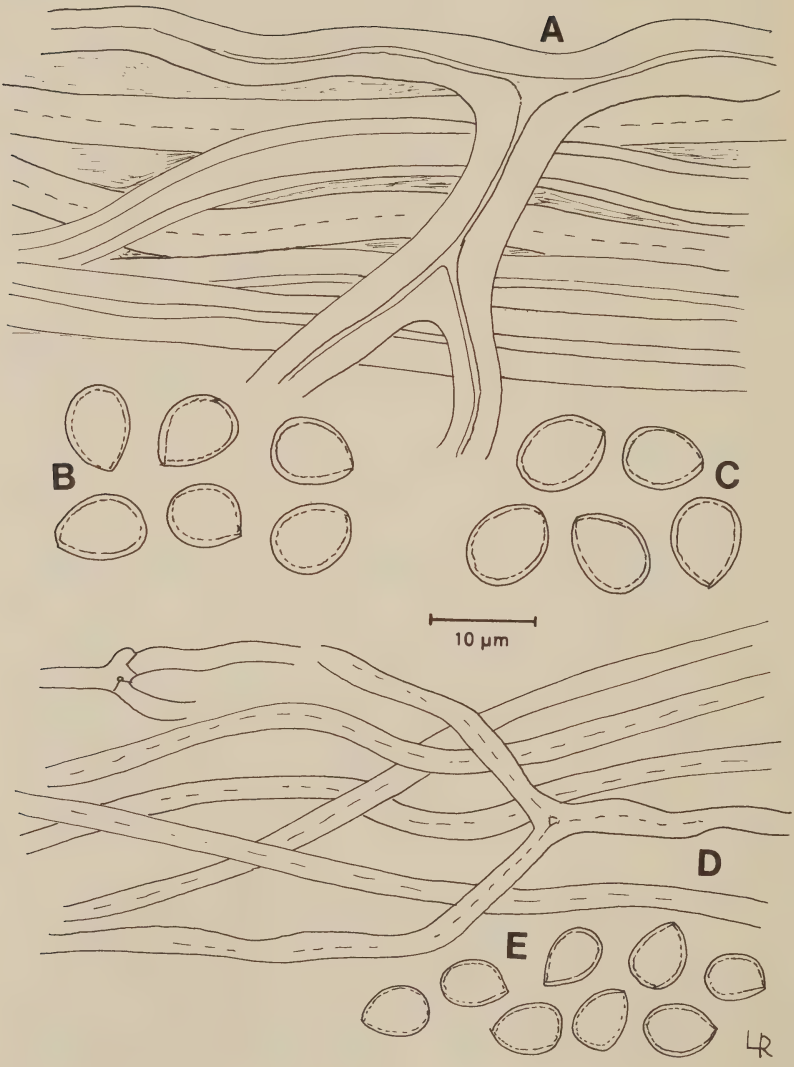

Fig.1. Perenniporia robiniophila, A) skeletal hyphae, B) spores. Coll. S. Ahmad 28120, C) spores, from the type. Perenniporia ahmadii, D) skeletal and generative hyphae, E) spores, from the type.

Overholts (op. cit.) reported that *Robinia* was the most common host, but that it seemingly was best developed on *Celtis*, i.e. the same host as for the Pakistan collection. The species has not previously been reported from outside the United States and there is no description in Ahmad (1972) and Bakshi (1971) which indicates, at least to me, that the species has been described under a different name. Unless a microscopical examination is carried out the species may easily be mistaken for a Trametes species.

Representative specimens:
USA. Virginia: Falls Church, Dec. 1903. On *Robinia* sp. leg. W. A. Murrill (NY). Type specimen. Tennessee: Great Smokey Mts. Loudon Co. Sugarland camp ground. 6. Sept. 1977. On *Robinia* sp. L. Ryvarden 14109 (O). Knoxville, leg. H. Hesler 25. Sept. 1933. On living *Celtis* sp. Overholts coll. no 16252. (DAOM).
INDIA: Punjab, Kasauli. 23. April 1971. Substr. unknown. Leg. R. S. Dhanda. Panjab Univ. Herb. no 6438 (O,).
PAKISTAN: Daphar, Rest House, 21. Aug. 1981. On living *Celtis australis*. Leg. S. Ahmad 28120 (O, Ahmad priv. herb.).

PERENNIPORIA AHMADII Ryv. nov. sp.

Fructificatio sessilia, pileus ochraceus ad pallide brunneus, glabrus, pori facies albus ubi vivus brunneus ubi siccus, contextus ochraceous, caseosus, systema hypharum dimitica, hyphae generatoriae hyalinae, tenuitunicatae, fibulatae, hyphae skeletales crasse tunicatae usque solidae, 2-3 um in diameter, non-dextrinoideae, sporae subglobosae, 5-6 x 4.5-6 um, infirme dextrinoideae.
Type: Pakistan, Sialkat, August 1952, leg. Shankat Ali. S. Ahmad herb. no. 4801 (O, holotypus, lectotypes in K, and Ahmad priv. herb.). Named in honour of Dr. S. Ahmad who has made so many important contributions to the knowledge of the mycoflora of Pakistan.

Fruitbody pileate, sessile, semicircular up to 8 cm wide and long in the type, about 2 cm thick at the base, probably soft when fresh, fragile and hard when dry. Pileus glabrous, azonate, smooth to warted, white when fresh, pale ochraceous to leather-coloured when dry. Pore surface white when fresh, brown when dry and tubes as if soaked with some resinous substance and strongly contrasting with the pale context, pores angular and thin-walled, 2-4 per mm, tubes up to 6 mm deep. Context pale cream, homogeneous, cheesy and crumbly when rubbed, up to 1.5 cm thick.
Hyphal system dimitic, generative hyphae with clamps, very difficult to observe, 2-3 µm wide, skeletal hyphae dominating, unbranched, only very rarely dichtomously branched, solid, narrow, 2-3 µm wide and non-dextrinoid. Basidia not seen. Spores subglobose, slightly thick-walled, 5-6 x 4.5-5 µm in Melzers reagent, slightly larger (5-7 x 5-6 µm) in 3% KOH, weakly dextrinoid.
Found on deciduous wood. Only the type has been examined.

On sight the type specimen reminds of an old and weathered specimen of Laetiporus sulphureus, but a microscopical examination at once rules out any affinity to this species.

P. robiniophila has a superficial resemblance to P. ahmadii because of its similar pileus. Furthermore, in both species the tubes become darker when dried while the pale context remains unchanged, However, P. ahmadii has narrow and non-dextrinoid skeletal hyphae, while they are wide and strongly dextrinoid in P. robiniophila. The consistency of the two species is also different, being cheesy and crumbly in P. ahmadii, tough in P. robiniophila. The spores of the two species are also different in size, although of the same general shape.

I extend my sincere thanks to Dr. S. Ahmad for sending me so many collections over the last few years.

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LACTARIUS NEOTABIDUS NOM. NOV. FOR *LACTARIUS CANADENSIS* SMITH

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A little known 24 page handbook by Winder (1871) gives descriptions and engravings of eight common Canadian macrofungi along with a list of 101 additional fungi. In the addenda on the unnumbered page 24 a new species, *Lactarius canadensis*, was proposed as follows:

> "I have also found near Toronto, a new species of Lactarius. I do not think it has been described before; and finding it in Canada only, I have proposed to name it the Canadian Blue Fungus, LACTARIUS CANADENSIS. It is from 4 to 8 inches in diameter, the gills are crowded, and run down the ringless stem. The pileus, at first is convex, at length concave; the plant is firm and woody, and grows in autumn, in pine woods. When the plant is bruised, bright blue milk exudes, which soon changes to green. This plant not edible."

The description clearly identifies the fungus as *Lactarius indigo* (Schw.) Fries, which was described from North America by Schweinitz

(1822). *Lactarius indigo* is an edible species. Although Winder stated that his fungus was not edible little importance can be attached to the comment as he apparently had not eaten the species (p. 20). The use of the words, "firm and woody" is unfortunate as the species is normally fleshy, however if it develops slowly it may be firm and even hard.

The validly published name, *Lactarius canadensis* Winder, had not been indexed (Saccardo's lists, Petrak's lists, Index of Fungi) prior to the publication of the later homonym, *Lactarius canadensis* Smith in Hesler & Smith (1960). The latter species is closely allied to a European species, *Lactarius tabidus* Fries as recognized by Neuhoff (1956), but seems to represent a distinct North American counterpart (Hesler & Smith 1979). Therefore, the new name, *Lactarius neotabidus* Smith, is proposed to replace *Lactarius canadensis* Smith, Brittonia 12: 346, 1960.

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PRODUCTION OF HYBRIDOMAS SECRETING MONOCLONAL ANTIBODIES TO THE GENUS FUSARIUM

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ABSTRACT

The production of eleven stable hybridomas obtained by fusion of a mouse myeloma cell line (NS-I) with spleen cells from a mouse previously immunized witth spores of Fusarium oxysporum f.sp. lycopersici is described. Supernatants from four of the specific hybridomas showed clear-cut quantitative differences in binding among the various panel spores. These quantitative differences permitted clear differentiation among Fusarium species, as well as among different formae speciales of F. oxysporum.

INTRODUCTION

Serological studies have provided a useful supplement to morphological criteria for the classification of the genus Fusarium (Tempel, 1959; Hornok, 1980; Iannelli et al., 1982). These studies have all been carried out using antisera raised in vivo, which generally contain many antibody populations directed against distinct antigenic determinants. Polyspecific antisera produced in vivo, because of their inherent heterogeneity, delineate an undefined part of the overall, rather than individual antigenic determinants. Furthermore, they are often unable to discriminate among small antigenic differences on an otherwise identical background or small antigenic similarities on a different background. The heterogeneity of antisera produced in vivo can be reduced by absorption in vitro of unwanted antibody specificities. This approach may have very useful results sometimes (Iannelli et al., 1982) but cannot provide a general solution to the problem which almost invariably is posed to the serologist of how to obtain antibodies specific for one antigenic determinant. To circumvent the limitations inplicit to the antibodies raised in vivo, we introduced into our studies on the antigenic dissection of the genus *Fusarium* Link ex Fr. the use of monoclonal antibodies, which represent one single population of antibody-combining sites (Köhler and Milstein, 1975, 1976).

We report here the production of hybridoma-derived monoclonal antibodies against *F. oxysporum* f. sp. *lycopersici*.

MATERIALS AND METHODS

Fungi - The isolates used in the present study were grown as already described (Iannelli et al., 1982). They include 16 representatives of *formae speciales* or physiological races of *F. oxysporum* and one of *F. moniliforme* and *F. xylarioides*, respectively (Table 1).

Immunization of mice - Three female Balb/c mice, approximately two months old, were immunized by intraperitoneal (i. p.) inoculation with 100 µl of phosphate buffer pH 7.2 (PBS) containing 10^7 spores from *F. oxysporum* f. sp. *lycopersici* isolate Fc 1513 (Ly 1513) emulsified in 100 µl of complete Freund adjuvant (Difco). Approximately one month later the mice were bled and sera assayed for specific reactivity to Ly 1513 spores by solid-phase antibody-binding assay (SABA). The mouse with the highest antibody titer was given an i. p. booster dose of 10^7 spores in 200 µl of PBS. Three days later the spleen was removed for fusion.

Media - RPMI 1640 (GIBCO) was freshly supplemented with 1 mM sodium pyruvate (Flow), 2 mM glutamine (Gibco), 60 µg/ml tylocine (Gibco), 100 μg/ml kanamycin (Gibco), I0% (v/v) heat inactivated (45 min at 56C) horse serum (Flow) and I0% heat inactivated foetal calf serum (Flow). This medium, here designated "basic medium", was used to prepare: (i) a medium containing I00 μM hypoxanthine (Sigma) and I6 μM thymidine (Sigma), here designated "HT medium"; (ii) a medium containing I00 μM hypoxanthine (Sigma), 0.4 μM aminopterin (Sigma) and I6 μM thymidine (Sigma), here designated "HAT medium"; (iii) a medium containing I00 μM 8-azaguanine (Sigma), here designated "Ag-8-medium".

Production of hybridomas - The mouse myeloma cell line used in this study was NS-I, a non-immunoglobulin-secreting, 8-azaguanine-resistent cell line of Balb/c origin (Köhler et al., I976). NS-I was maintained in Ag-8-medium. For cell fusion, $I0^8$ spleen cells (the whole mouse spleen) were mixed with $I0^7$ myeloma NS-I cells harvested in logarithmic phase, washed three times with RPMI I640 in a 50 ml conical polypropylene tube by centrifugation for 5 min at 200 x g. To the well-drained pellet, warmed at 37 C, 0.5 ml of 50% (w/v) polyethylene glycol 4000 (Merck cat. n. 9727) in RPMI I640 was added during one min under constant agitation. The cells were centrifuged for one min at 200 x g, then added 50 ml of RPMI I640 (at the beginning dropwise). The cells were pelletted again (I0 min at 200 x g), resuspended in 50 ml of HT medium and distributed in 94 wells 2 cm diameter (Costar) containing one ml of HT medium and $I0^5$ mouse peritoneal macrophages as feeder layer. The cultures were incubated at 37 C in air containing 5% CO_2 at 95% humidity. On the third day from fusion, HT medium was replaced with HAT medium to select against the myeloma parent cells. Cloning of positive hybridomas was carried out by the limiting dilution method (Hengartner et al., I978).

Solid-phase antibody-binding assay (SABA) - Polyvinyl chloride microtiter plates (Dynatech Laboratories, Alexandria, Va, USA) were first coated with concanavalin A (Pharmacia, Uppsala, Sweden). After I h at 25 C the lectin solution (I00 μg/ml of PBS; 50 μl/well) was removed and each well received approximately 0.5 x $I0^6$ spores suspendend in 50 µl of PBS. After I h at 25 C the spores were fixed with 0.25% (v/v) glutaraldehyde (Merck) in PBS by the method of Stocker et al.(I979). The wells were filled with 3% bovine serum albumin (BSA) in PBS and kept for I h at 25 C to block all protein binding sites. The plate was then washed four times with PBS. Hybridoma culture supernatants (50 µl) were incubated in duplicate wells overnight at + 4 C. Control assays (background binding) were performed on wells coated only with 3% BSA. After washing four times with PBS, 50 µl of sheep anti-mouse immunoglobulin antibody purified by affinity chromatography and labeled with ^{I25}I (50-I00xI0^3 cpm) were added to each well and incubated at 25 C for about 6 h. The plate was washed four or five times with PBS, cut into individual wells and counted in a gamma scintillation spectrometer.

RESULTS

At I5 days following fusion, 80 out of 94 culture wells into which the hybrid cell mixture was distributed contained viable cells growing in HAT selective medium. Control wells (one with splenocytes, one with myeloma cells only) contained no viable cells at this time. Initial screening of culture supernatants was performed by SABA using as target the spores from isolate Ly I5I3, with which the mouse used for fusion had been immunized. Supernatants were tested for specific antibodies when cultures were about 20-30% confluent (I5-30 days after fusion). From the 80 supernatants tested, II yielded high antibody binding. Positive cultures (all II) were cloned as soon as possible to prevent loss of cells secreting specific antibodies by overgrowth of non specific clones. For each cloned hybridoma, 5-I0 wells containing one single colony were tested for activity and the cells of two active wells were expanded and frozen. The supernatants from one clone of each original positive culture was finally tested against the spores of I8 isolates, I6 of which are representatives of formae speciales or physiological races of F. oxysporum and one of F. moniliforme and F. xylarioides, respectively. Supernatants from 7 specific hybridomas displayed almost uniform binding to all of the isolates tested. They presumably recognize with about equal affinity determinant(s) common to all isolates. Supernatants from the remaining 4 hybridomas showed characteristic binding patterns (Fig. I).

The supernatant from clone 8G3 showes a particularly high binding to *F. xylarioides*: the difference in mean binding value observed between the isolate Fc I503 (*F. xylarioides*) and the isolate Fc I344 (*F. moniliforme*), giving next higher mean binding value, is about $I0^3$ cpm (4I03 cpm vs. 3087 cpm).

Supernatant from clone 9E6 binds to the isolates of *F. oxysporum* f. sp. *melonis* appreciably less than to the remaining ones of the panel: the isolate Fc I376-B (the most reactive among the representatives of *F. oxysporum* f. sp. *melonis*) gives a mean binding value (5882 cpm) which is about 80% of that for the isolate Fc I503 (*F. xylarioides*), giving next lower mean binding value (7406 cpm).

Supernatants 7H2 and 5AII both show higher binding than 8G3 and 9E6 to the majority of isolates tested.

The antibodies produced by the clone 7H2 display low binding to *F. moniliforme*: Fc I344 (*F. moniliforme*) gives a mean binding value (5843 cpm) which is about 42% of that observed for I503 (*F. xylarioides*), giving next lower mean binding value (I4030 cpm). The same antibodies bind very effectively with *F. oxysporum* f. sp. *dianthi*: the difference in mean binding value observed between the isolate Fc I550 (the less reactive of the two representatives of *F. oxysporum* f. sp. *dianthi*) and Fc I376-A (*F. oxysporum* f. sp. *melonis*), giving the next higher mean binding value, is about $5xI0^3$ cpm (26265 cpm vs. 2I293 cpm).

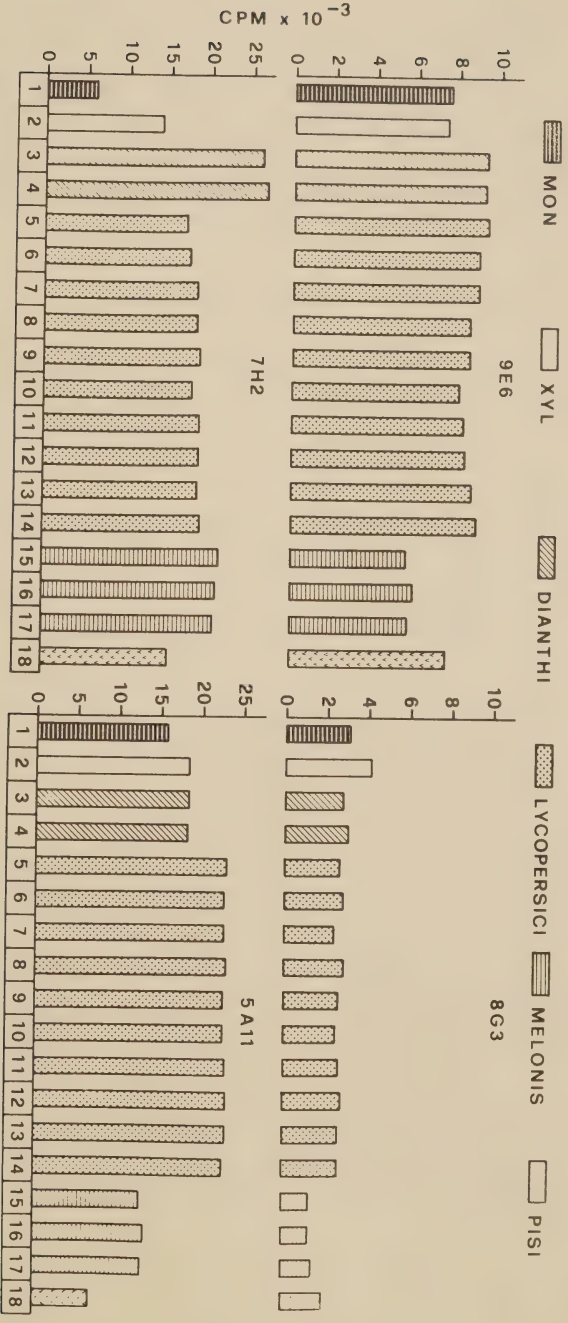
A still different pattern of reactivity is observed with the antibodies from clone 5AII. Again two features are of particular interest. First, the very low binding of these antibodies to Fc II25, representative of *F. oxysporum* f. sp. *pisi*. This isolate gives a mean binding value

Table I. *Fusarium* isolates used for serological analysis.

Name	Isolate	Race	Source
F. moniliforme Sheld.	FcI344-A		P.Alghisi(Padua)
F. xylarioides Stay.	FcI503-I		W.Gerlach(Berlin)
F. oxysporum f. sp. *dianthi* (Prill. et Del.) Snyd. et Hans.	FcI550	2	OC°(Naples)
	FcI572	2	OC (Naples)
F. *oxysporum* f. sp. *lycopersici* (Sacc.) Snyd. et Hans.	FcI006	I	OC (Naples)
	FcI233	I	OC (Caserta)
	FcI5I3	I	OC (Naples)
	FcI599-A	I	A.Garibaldi(Turin)
	FcI599-B	I	A.Garibaldi(Turin)
	FcI599-C	I	A.Garibaldi(Turin)
	FcI599-D	I	A.Garibaldi(Turin)
	FcI674-A	I	M.Cirulli(Bari)
	FcI674-B	I	M.Cirulli(Bari)
	FcI723	I	OC (Caserta)
F. oxysporum f. sp. *melonis* Snyd. et Hans.	FcI376-A	I	(Montfavet)
	FcI376-B	2	(Montfavet)
	FcI376-C	3	(Montfavet)
F. oxysporum f. sp. *pisi* (van Hall Snyd. et Hans.	FcII25		P.Gambogi(Pisa)

° OC = own collection.

Fig. I. Histograms showing SABA results with 4 monoclonal antibodies and I8 *Fusarium* isolates. All determinations, including albumin background values, were done simultaneusly in duplicate wells. I = *F. moniliforme*, isolate Fc I344-A; 2 = *F. xylarioides*, isolate FcI503-I; 3-4 = *F. oxisporum* f. sp. *dianthi*, isolates FcI550 and FcI572, respectively; 5-I4 = *F. oxysporum* f. sp. *lycopersici*, isolates FcI006, FcI233, FcI5I3, FcI599-A, FcI599-B, FcI599-C, FcI599-D, FcI674-A, FcI674-B and FcI723, respectively; I5-I7 = *F. oxysporum* f. sp. *melonis*, isolates FcI376-A, FcI376-B and FcI376-C; I8 = *F. oxysporum* f. sp. *pisi*, isolate FcII25.


CPM x 10^{-3}
MON
XYL
DIANTHI
LYCOPERSICI
MELONIS
PISI
9E6
7H2
8G3
5A11
0
2
4
6
8
10
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10
15
20
25
1
2
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10
11
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14
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17
18

FIG. 1.

(68I2 cpm) which is 53% of that for Fc I376-A (*F. oxysporum* f. sp. *melonis*), giving next lower mean binding value (I285I cpm). Second, the high binding to the *F. oxysporum* f. sp. *lycopersici*. The difference in mean binding value between Fc I599-C (the least reactive among the isolates of *F. oxysporum* f. sp. *lycopersici*) and Fc I572 (representative of *F. oxysporum* f. sp. *dianthi*) giving next higher mean binding value, is about 4.4 x IO^3 cpm (22672 cpm vs. I8250 cpm).

DISCUSSION

The present study describes the production and initial characterization of eleven stable hybridomas obtained by fusion of a myeloma cell line (NS-I) with spleen cells from a mouse previously immunized with spores of *F. oxysporum* f. sp. *lycopersici*.

At the beginning of this work we anticipated, perharps optimistically, that at least some of the hybridoma-secreted antibodies would be directed against antigenic determinants present on some but not all of the target cells and would give rise to an " all or none" pattern of binding. Unfortunately, none of them conformed to this expectation. With antibodies from four of our clones, we could however detect clear-cut quantitative differences in binding of the various spores which we tested. We cannot interpret, at present, the nature of the observed differences: whether they reflect diversity between the various target cells in the total number of the same identical antigenic determinant or diversity in affinity of antibodies for an antigenic determinant which is similar but not identical between the various target cells. These quantitative differences, independently from their nature, enabled us to differentiate clearly between *Fusarium* species, as well as between different *formae speciales* of *F. oxysporum*. For instance, *F. moniliforme* and *F. xylarioides* could be distinguished because of their different binding to the antibodies from clone 8G3 and the four *formae speciales* *lycopersici*, *dianthi*, *pisi* and *melonis* through their individual binding pattern to the antibodies from clones 5AII, 7H2, 5AII, 9E6, respectively.

Monoclonal antibodies represent a strictly homogeneous population of immunoglobulin molecules directed against a single determinant. This property makes them valuable as diagnostic reagents but even more as probes to study basic aspects of fungal biology such as the antigenic fine architecture of spore surface, the stability of single isolates in the laboratory and in nature, host-parasite relationships. Our next goal will be to use our hybridoma-derived antibodies in immunofluorescence tests to localize single antigenic determinants on the surface of the spore and determine their number, arrangment and distribution.

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THE GENUS APIOSORDARIA[1]

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SUMMARY

Echinopodospora Robison and *Lacunospora* Cailleux are placed in synonymy with *Apiosordaria* v. Arx et Gams. *Jugulospora* Lundq. is retained as a separate genus. The evidence for these dispositions is discussed. *A. tetraspora* sp. nov. is described and illustrated along with a revised generic description. A key to all recognized species is presented. *A. tuberculata* nom. nov. is erected for *Tripterospora verruculosa* Cailleux. New combinations are proposed for *Echinopodospora effusa* Morinaga et al., E. jamaicensis Robison, *E. sacchari* Robison, *E. terrestris* Jong et Davis, *E. vermicularis* Morinaga et al., *Lacunospora longicaudata* Furuya et Udagawa, and *Triptero-*

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spora spinosa Cailleux. An enumeration of all previously erected taxa is included.

INTRODUCTION

During the past decade considerable attention has been focussed on the kind of spore ornamentation in the Sordariaceae. This has proven to be a useful taxonomic criterion and has resulted in the erection of a number of new genera. These are based primarily on the variation in the surface ornamentation of the ascospores. It may take the form of warts (*Copromyces*, Lundqvist 1967), pits, spines, ribs, plates (*Emblemospora*, Jeng and Krug 1976), or a combination of ribs and pits in the case of *Rhexosporium* (Udagawa and Furuya 1977).

One of the genera with ornamented ascospores is *Apiosordaria* v. Arx et Gams (1967) based on *Pleurage verruculosa* Jensen, a species characterized by spiny spores. Cailleux (1968) then erected *Lacunospora* for a single species, *L. stercoraria*, with a pitted perispore. Subsequently, Robison (1970) described *Echinopodospora* for two species resembling *Apiosordaria* but possessing cleistothecial ascocarps. More recently Furuya and Udagawa (Furuya 1978) described *Lacunospora longicaudata* for an isolate with a pitted spore wall, originally referred to *A. verruculosa* var. *maritima* (Apinis et Chesters) v. Arx et Gams. Subsequently, Udagawa (1980) erected *A. rugosa* which has pitted ascospores with rugose flanges. Morinaga, Utatsu and Minoura (1979) described *A. yaeyamensis* which has spores with flat topped spines and Udagawa and Muroi (1981) added *A. microcarpa* for an organism with agglutinated perithecial hairs and spiny spores. Then Udagawa and Horie (1982) erected *A. vestita* for another species with agglutinated hairs but possessing pitted spores. Meanwhile von Arx (1981) transferred *Jugulospora rotula* (Cke.) Lundq. and *Lacunospora stercoraria* Cailleux to *Apiosordaria*. A number of species have been added to *Echinopodospora* by Malloch and Cain (1971), Jong and Davis (1974), and Morinaga, Minoura and Udagawa (1978). They differ from the original species in both spore size and details of the ornamentation.

In considering the evolution of the ascocarp, Cain (1956) suggested that the cleistothecium is an advanced feature resulting from progressive evolution. He went on to suggest that its presence does not indicate relationships but that it has appeared in a large number of different evolutionary lines. Accordingly, it is not surprising to find examples of closely related organisms both with and without an ostiole, such as *Gelasinospora* Dowding and *Anixiella* Saito et Minoura. Von Arx (1973) has shown that the presence of an ostiole is so variable that it is of little use in defining genera. In some instances it may be of little significance even at the specific level, its presence depending on cultural and ecological factors.

Based on such considerations, there seems to be little justification in maintaining *Echinopodospora* as a separate genus from *Apiosordaria*, the only essential difference being the cleistothecial ascocarp. Likewise, a consideration of the perispore in *Apiosordaria* and *Lacunospora* appears to indicate that the two genera are synonymous. SEM illustrations have been published by Cailleux and Meléndez-Howell (1970) and Udagawa (1980) for *L. stercoraria*, while *L. longicaudata* has been illustrated in this manner by Furuya (1978) and Udagawa and Furuya (1972). Both taxa illustrate the pitted nature of the perispore. In *A. verruculosa* and *E. effusa* respectively, SEM studies by Udagawa and Furuya (1975) and Morinaga et al. (1978) illustrate a spiny perispore. When one examines the SEM photograph for *A. verruculosa var. maritima* a more intermediate type of ornamentation is observed which is broader and more wart-like. Further intermediates are seen in *A. rugosa* which has a pitted, rugose perispore and *A. terrestris* in which an irregular reticulum is observed. These results appear to indicate that the difference between the pitted and echinulate perispore is merely in the diameter of the pit. Unpublished SEM observations for additional collections from both genera further strengthen this conclusion. The published SEM information illustrates the presence of a minute appendage at each end of the ascospore in both genera. Furthermore, a *Cladorrhinum* anamorph has been observed in species with both the pitted and echinulate perispore.

Accordingly, we have come to the same conclusion as von Arx (1981) that there is little to separate *Apiosordaria* and *Lacunospora*. The necessary transfers from both *Echinopodospora* and *Lacunospora* are being proposed. Von Arx (1981) has also placed *Jugulospora* Lundq. in synonymy with *Apiosordaria*. However, the difference in the structure of the ascospore wall and the nature of the pits as seen under SEM would seem to support the retention of *Jugulospora* as a separate genus.

TAXONOMY

Apiosordaria v. Arx & Gams, Nova Hedwigia *13:* 201. 1967.
= *Lacunospora* Cailleux, Cahiers La Maboké *6:* 93. 1968.
= *Echinopodospora* Robison, Trans. Br. mycol. Soc. *54:* 318. 1970.

Ascocarps saprophytic, scattered to clustered, erumpent to superficial, ostiolate or non-ostiolate, non-stromatic, dark brown to black, globose or pyriform, glabrous or hairy; peridium usually pseudoparenchymatous, membranous or somewhat coriaceous, two or more layers thick. *Asci* unitunicate, non-amyloid, four- or eight-spored, cylindrical or clavate, stipitate, formed in a basal fasicle; apical ring indistinct or absent. *Paraphyses* usually present, filiform, hyaline. *Ascospores* two-celled or occasionally becoming three-celled, composed of a dark upper cell and a lower hyaline cell; upper cell ellipsoidal to subglobose, dark brown to almost black, with walls ornamented with numerous broad or narrow pits, possessing a minute apical hyaline appendage and a single germ pore; lower cell triangular to cylindrical, hyaline, possessing a minute hyaline terminal appendage. *Conidia* when present usually phialidic *(Cladorrhinum)* or occasionally as aleurospores *(Chrysosporium)*, subglobose to ovate, hyaline or pale yellow-brown, smooth-walled.

ETYMOLOGY: Greek, *apios* = pear-tree + the generic name *Sordaria*, derived from Latin, *sordidus* = dirty, referring to the pyriform shape of the ascocarp.

TYPE SPECIES: *Pleurage verruculosa* Jensen.

Key to the Species

1. Ascospore wall with broad pits; ornamentation appearing as spines or irregular warts 2
1. Ascospore wall with narrow pits; ornamentation appearing as pits 12
2. Pits formed within wall and projecting inward, anastomosing .... *Jugulospora rotula*
2. Pits formed at surface of wall, not anastomosing 3
3. Asci 4-spored 4
3. Asci 8-spored 6
4. Ascocarp non-ostiolate, lower cell of ascospores 4-6 μm long; anamorphs *Cladorrhinum* and *Chrysosporium* .... *A. effusa*
4. Ascocarp ostiolate, lower cell of ascospores 6-11 μm long 5

5. Upper cell of ascospores usually 24-30 µm long, sometimes 28-34 (-45) µm long; ornamentation spine-like (often flat-topped), about 3 µm long; anamorph *Cladorrhinum* .... *A. verruculosa var. verruculosa*
5. Upper cell of ascospores usually 19-23 µm long, sometimes up to 27 µm long; ornamentation wart-like, about 1.5 µm long; anamorph *Cladorrhinum* .... *A. verruculosa var. maritima*
    6. Ascocarps with agglutinated hairs, ostiolate; upper cell of ascospores 15-19 x 10-12.5 µm, lower cell 5-6.5 µm long; anamorph *Chrysosporium* .... *A. microcarpa*
    6. Ascocarps lacking agglutinated hairs, ostiolate; upper cell of ascospores 10-12.5 x 6-8 µm with flat-topped spines, lower cell 4-6 µm long; anamorph absent .... *A. yaeyamensis*
    6. Ascocarps smooth or with another type of vestiture, non-ostiolate; ascospores (in total) typically larger 7
7. Ascospores with a granulose to wart-like ornamentation, lower cell 4-5 µm long; anamorph not recorded .... *A. tuberculata*
7. Ascospores with spine-like ornamentation or flat-topped ridges, lower cell longer 8
    8. Asci cylindrical and curved; upper cell of ascospores 16-20 (-22) x 12-15 µm, lower cell frequently transversely septate, 12-20 µm long; anamorphs *Cladorrhinum* and *Chrysosporium* .... *A. vermicularis*
    8. Asci clavate; upper cell of ascospores larger, lower cell non-septate 9
9. Ornamentation of ascospores 2-5.5 µm long, upper cell (24-) 25-32 x 18-21 (-22) µm, lower cell 4-8 µm long; anamorph *Chrysosporium* (when

present) .... A. spinosa

9. Ornamentation of ascospores shorter (up to 3 µm), lower cell longer 10
    10. Upper cell of ascospores 33-40 x 25-31 µm, lower cell 14-20 µm long; anamorph absent .... *A. sacchari*
    10. Upper and lower cells of ascospores shorter 11

11. Ornamentation of ascospores spine-like, upper cell 24-30 x 17-23 (-26) µm, lower cell about 11-18 µm long; anamorph *Chrysosporium* (when present) .... *A. jamaicensis*

11. Ornamentation of ascospores as irregular flat-topped ridges forming an incomplete reticulum, upper cell 28.5-33 x 17-19.5 µm, lower cell about 8-10 µm long; anamorph *Chrysosporium* .... *A. terrestris*
    12. Asci 4-spored 13
    12. Asci 8-spored 15

13. Upper cell of ascospores 17.5-24 x 12.5-16.5 µm, lower cell 10-14 µm long; anamorph *Cladorrhinum*; terricolous .... *A. longicaudata*

13. Lower cell of ascospores shorter; usually coprophilous 14
    14. Ascospores (in total) 28-33 x 17-21 µm, lower cell 3-5 µm long; anamorph absent; coprophilous .... *A. stercoraria*
    14. Ascospores (in total) 26-33 (-36) x 12.5-17 µm, lower cell 4-7.5 (-10) µm long; anamorph *Cladorrhinum*; coprophilous or terricolous .... *A. tetraspora*

15. Ascocarp with agglutinated hairs; ascospores (in total) 24-30 x 12-15 µm, lacking flanges, lower cell 4-5 µm long; anamorph *Cladorrhinum* .... *A. vestita*

15. Ascocarp glabrous; ascospores (in total) (16-) 18-21 (-23) x 10-12 µm, with rugose flanges, lower cell 2.5-5 µm long; anamorph absent . . *A. rugosa*

Apiosordaria tetraspora sp. nov. Figs. 1-8

Coloniae in agaro "Leonian" ad 9 cm. diametrum in octo diebus crescentes, primum e subroseis, deinde griseae, tenues, azonatae. Perithecia dispersa, immersa, subglobosa vel pyriformia, ostiolata, atriolivacea vel atribrunnea, 265-375 x (220-) 250-315 µm magna, pilis flexuosis, rectis, septatis, pallide olivaceis vel pallide brunneis, usque 320-450 (-480) x 2-4 µm magnis praedita; perithecii collum papilliforme, nigrum, 70-105 x 60-90 (-120) µm magnum; peridium membranaceum vel leviter coriaceum, pseudoparenchymatosum, primum hyalinum, deinde obscure olivaceibrunneum, e stratis duobus compositum. Asci cylindracei, tetraspori, 110-165 x 14-18 µm magni, in apice leviter obtusi, basin versus in stipitem 30-50 µm longum attenuati; annulum apicale parvum. Paraphyses numerosae, filiformes vel vesiculares, hyalinae, septatae, in apice 3-7 µm crassae. Ascosporae oblique uniseriales, primum unicellulares, deinde bicellulares, 26-33 (-36) x 13-17 µm magnae, e cellula superiore atra et cellula inferiore hyalina sistentes, appendicem gelatinosam unam in utroque apice gerentes; cellula superior late ellipsoidea, ad basin truncata, primum lutea vel olivacea, maturitate confirmata atribrunnea vel paene nigra et opaca, 19-26 µm longa, foveas numerosas, minutas, 1-1.5 µm crassas exhibentes; cellula inferior parva, triangularis vel conica, 4-7.5 (-10) x 6-8 (-12) µm magna, hyalina vel pallide luteola, persistens, foveas paucas, inconspicuas exhibentes; foramen germinale apicale, rotundum, parvum.

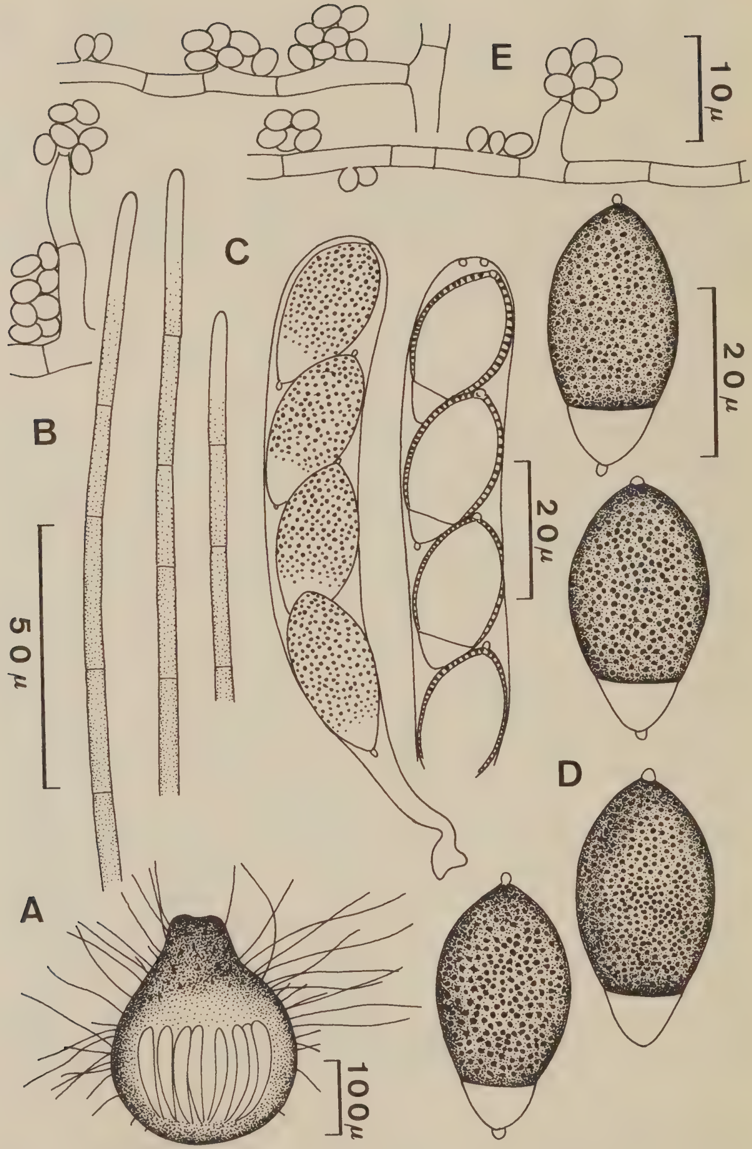
Conidiophora simplicia, e monophialidis aut interdum polyphialidibus composita; phialides cylind-

raceae vel ampulliformes, 4-16 x 1.7-4 µm magnae, ad apicem collula procurrens exhibentes. Conidia ovoidea vel ellipsoidea, 2.5-4.5 x 1.4-2 µm magna, hyalina, laeves.

HOLOTYPUS: In vaccarum fimo lectus est, in loco a Guasipati 10 km septentrionali vocato, in Bolivar pago reipublicae Venezuelensis, 3 Sext. 1972, *Dumont*, *Cain*, *Samuels* et *Blanco* VE-7055aa. In Torontoensis universitatis Cryptogamarum herbario.

ETYMOLOGY: Greek, *tetra* = four and *spora* = seed, referring to the four-spored asci.

Colonies on modified Leonian's agar medium spreading broadly, reaching a diameter of 9 cm in 8 days at 25° C, thin, azonate, at first with a pinkish tinge, becoming grey, reverse black; on oatmeal (with wheat germ powder) medium somewhat floccose in appearance, dark yellowish brown to black, reverse pale brown; aerial hyphae abundant, loose, with conidial structures, 1.5-6 µm in diameter, hyaline, septate, branched. *Ascocarp initials* originating as coiled hyphae of vegetative mycelium soon involving neighbouring hyphae. *Perithecia* unevenly scattered or aggregated in small clusters, embedded or partially immersed, subglobose to pyriform, ostiolate, dark olivaceous brown to black brown by transmitted light, black by reflected light, 265-375 x (220-) 250-315 µm, covered with numerous, flexuous, straight, septate, light olivaceous to light brown hairs rounded or collapsed at the apex and measuring up to 320-450 (-480) x 2-4 µm; neck short, papilliform, black, 70-105 x 60-90 (-120 at base) µm; ostiole apical, central, lined with numerous, hyaline, septate periphyses measuring 30-45 x 3-5 µm; peridium 12-20 µm in thickness, membranaceous to rather coriaceous, pseudoparenchymatous in surface view, initially hyaline to semitransparent, becoming dark olivaceous brown and


E
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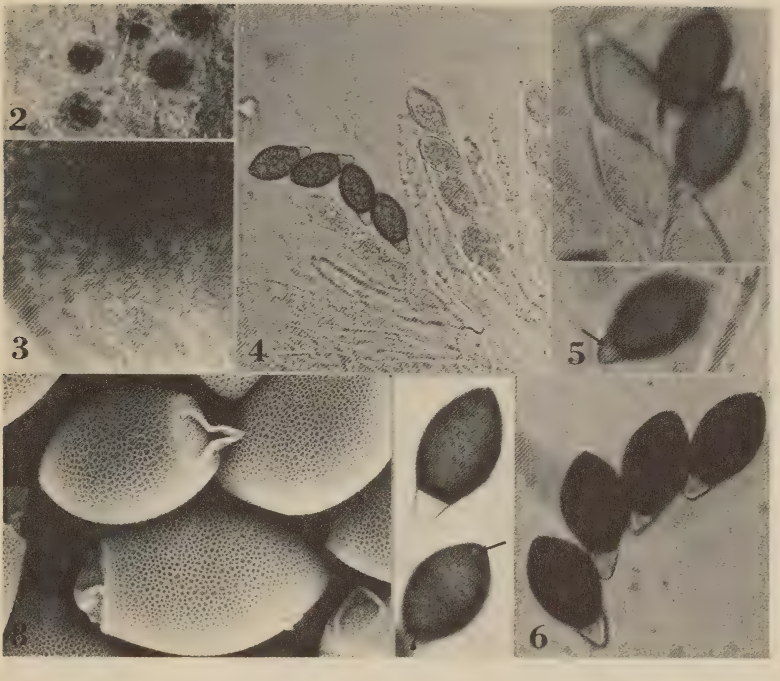

Fig. 1. *Apiosordaria tetraspora* (NHL 2781). a) Perithecium. b) Perithecial hairs. c) Asci and ascospores. d) Mature ascospores showing terminal appendages. e) Conidia and conidiophores. Figs. 2-8 *Apiosordaria tetraspora* (TYPE except fig. 8). 2) Habit view of perithecia. x 15. 3) Peridium in surface view showing uncarbonized basal portion. x 275. 4) Asci and ascospores. x 275. 5) Young ascospores showing spore wall with narrow pits. Note wall of lower cell (arrow) is occasionally pitted. x 685. 6) Mature ascospores with two showing upper terminal appendages. x 685. 7) Ascospores showing germ pore (arrow). x 685. 8) Ascospores under SEM showing pitted spore wall. x 1215 (NHL 2781).

opaque at maturity, 2-layered in section, outer peridial layer 6-9 µm in thickness, with angular cells, becoming carbonized, inner peridial layer 6-11 µm in thickness, with hyaline, flattened or elongated cells. *Asci* cylindrical, 4-spored (rarely 3-spored), 110-165 x 14-18 µm, slightly narrowed above, tapering below into a short stipe 30-50 µm long; apical ring small. *Paraphyses* abundant, filiform to vesicular, hyaline, septate, 3-7 µm in diameter at the apices. *Ascospores* obliquely uniseriate, initially one-celled, ellipsoidal to obovate, hyaline, 26-33 (-36) x 13-17 µm, becoming transversely uniseptate near the base, provided at each end with small, hyaline, easily detached appendages; upper cell broadly ellipsoidal, truncate at the base, yellow to olivaceous, finally dark brown to nearly black and opaque, 19-26 µm long, with walls uniformly ornamented with numerous tiny pits measuring 1-1.5 µm in diameter; lower cell small, triangular to conical, 4-7.5 (-10) x 6-8 (-12) µm, hyaline to pale yellowish, persistent but often collapsed at maturity, with walls ornamented with a few, inconspicuous pits; germ pore apical, circular, small.

Conidiophores simple, monophialidic on aerial hyphae or occasionally polyphialidic as an irregular branching system; phialides cylindrical to flask-shaped, 4-16 x 1.7-4 µm, often with a pronounced projecting collarette, sometimes reduced to mere collarettes on cells of the hyphae. *Conidia* Cladorrhinum-like, ovoid to ellipsoidal, 2.5-4.5 x 1.4-2 µm, hyaline, smooth-walled, aggregated in slimy masses measuring 6-8 µm in diameter.

HABITAT: on soil and animal dung.

SPECIMENS EXAMINED: JAMAICA: Central Uplands: Worthy Park Estate, soil and roots of sugar cane, 1966, *Robison*, TRTC 49127 (IMI, TRTC). THAILAND: Northeastern Part: near Nakhornratchsima, Nonsung, soil, 11 Dec. 1974, *Udagawa*, NHL 2781 (ATCC, CBS, NHL, PRM, S, TRTC). U.S.A.: Maine: York Co.: Kittery Point, skunk dung, July 1894, *Thaxter* 1549, ex herb. R.F. Cain 6414 (TRTC). VENEZUELA: Edo. Bolivar: 10 km N of Guasipati, cow dung, 3 Aug. 1972, *Dumont*, *Cain*, Samuels and *Blanco* VE-7055aa (ATCC, CBS, FH, IMI, TRTC, UPS).

The characteristic features of this species are the four-spored asci, the narrow pits in the ascospore wall and the length of the lower hyaline cell. Furthermore, the organism appears to be somewhat pan tropical in distribution. The only similar species is *A. stercoraria* which differs in possessing wider ascospores with a shorter lower cell, a prosenchymatous peridium and in being entirely coprophilous.

The Siamese isolate differs from the type in producing on Leonian's agar medium a wine-coloured extracellular exduate after six days of growth; on PDA a pale pink pigmentation is produced.

Previously Erected Taxa

Apiosordaria microcarpa Udagawa & Muroi, Trans. mycol. Soc. Japan *22:* 11. 1981.

Apiosordaria rotula (Cooke) von Arx, Genera of Fungi Sporulating in Pure Culture, ed. 3., p. 160. 1981.
= *Sphaeria rotula* Cooke, Handbook Brit. Fung. *2:* 868. 1871.
= *Jugulospora rotula* (Cooke) Lundq., Symbol. Bot. Upsal. *20*(1): 260. 1972.
(for additional synonyms see Lundqvist, 1972).

Apiosordaria rugosa Udagawa, Trans. mycol. Soc. Japan *21:* 17. 1980.

Apiosordaria stercoraria (Cailleux) von Arx, Genera of Fungi Sporulating in Pure Culture, ed. 3., p. 160. 1981.

= *Lacunospora stercoraria* Cailleux, Cahiers La Maboke *6:* 93. 1968.

Apiosordaria verruculosa var. **verruculosa** (Jensen) von Arx & Gams, Nova Hedwigia *13:* 201. 1967.

= *Pleurage verruculosis* Jensen, Bull. Cornell Univ. Agr. Exp. Stat. *315:* 472. 1912.

Apiosordaria verruculosa var. **maritima** (Apinis & Chesters) von Arx & Gams, Nova Hedwigia *13:* 203. 1967.

= *Pleurage verruculosis* var. *maritima* Apinis & Chesters, Trans. Brit. mycol. Soc. *47:* 432. 1964.

Apiosordaria vestita Udagawa & Horie, Misc. Publ. Nat. Sci. Mus. Tokyo, p. 97. 1982.

Apiosordaria yaeyamensis Morinaga, Utatsu & Minoura, Trans. mycol. Soc. Japan *20:* 493. 1979.

New Combinations

Apiosordaria effusa (Morinaga, Minoura & Udagawa) Krug, Udagawa & Jeng comb. nov.

= *Echinopodospora effusa* Morinaga, Minoura & Udagawa, Trans. mycol. Soc. Japan *19:* 135. 1978.

Apiosordaria jamaicensis (Robison) Krug, Udagawa & Jeng comb. nov.

= *Echinopodospora jamaicensis* Robison, Trans. Brit. mycol. Soc. *54:* 318. 1970.

Apiosordaria longicaudata (Furuya & Udagawa) Krug, Udagawa & Jeng comb. nov.

= *Lacunospora longicaudata* Furuya & Udagawa in Furuya, Trans. mycol. Soc. Japan *19:* 269. 1978.

Apiosordaria sacchari (Robison) Krug, Udagawa & Jeng comb. nov.

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Apiosordaria spinosa (Cailleux) Krug, Udagawa & Jeng comb. nov.

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Apiosordaria terrestris (Jong & Davis) Krug, Udagawa & Jeng comb. nov.

= *Echinopodospora terrestris* Jong & Davis, Mycologia *66:* 465. 1974.

Apiosordaria tuberculata Krug, Udagawa & Jeng nom. nov. (non *Apiosordaria verruculosa* (Jensen) v. Arx & Gams)

= *Tripterospora verruculosa* Cailleux, Cahiers La Mabokē *8:* 16. 1970.

= *Echinopodospora verruculosa* (Cailleux) Malloch & Cain, Can. J. Bot. *49:* 875. 1971.

Apiosordaria vermicularis (Morinaga, Minoura & Udagawa) Krug, Udagawa & Jeng comb. nov.

= *Echinopodospora vermicularis* Morinaga, Minoura & Udagawa, Trans. mycol. Soc. Japan *19:* 138. 1978.

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MYCOTAXON

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STUDIES IN THE GENUS HYPHODONTIA (BASIDIOMYCETES) I
HYPHODONTIA John Erikss. sectio HYPHODONTIA

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SUMMARY

Hyphodontia sensu stricto, sectio Hyphodontia, has been studied, viz. H. pallidula, type species of Hyphodontia, H. alutaria, and H. arguta. A new species, H. propinqua, found in east Africa, India, and Nepal, which is quite similar to other species in the section, is described. Type specimens of several taxa were also studied, viz. Peniophora alutaria Burt, Peniophora laminata Burt, Odontia chroospora Rick ex Rambo, Gonatobotrys pallidula Bres., and Hyphodontia pallidula var. alutarioidea Parm. Neotypes are designated for two taxa, Hydnum argutum Fr. and Hydnum fallax Fr. A key to the species of the section is provided.

HYPHODONTIA John Erikss., Symb. bot. Ups. 16(1):101, 1958.

GENERIC TYPE: Gonatobotrys pallidula Bres. (by original designation).

GENERITYPE SPECIMEN: Ad truncos Betulae et Pini, leg. Eichler (FH).

HYPHODONTIA sectio HYPHODONTIA

According to Parmasto (1968) the main characteristics of the sectio are: hymenium smooth or aculeate; septocystidia long, 1-9-septate, fibulate; lagenocystidia present; spores ellipsoid to broadly ellipsoid.
The species included in sectio Hyphodontia form a quite homogeneous group which above all are easily recognized owing to the combination of cystidial types (septocystidia and lagenocystidia). The tissues, with cystidial organs included, have a very slight dextrinoid reaction, the spores, however, are definitely not dextrinoid, (see further Weresub p. 1475, 1961). The cyanophilous reaction of hyphae and cystidia is more conspicuous than in other sections of the genus. The

spores are subglobose to ellipsoid and tend to be more or less pip-shaped (e.g. in *H. propinqua*), thin-walled, and apparently acyanophilous.

COMPREHENSIVE LITERATURE: Eriksson 1958, Eriksson and Hjortstam 1969, Eriksson and Ryvarden 1976, and Doll 1979.

Key to the species of the sectio *Hyphodontia*

1. Hymenium distinctly odontioid...............*H. arguta*
1. Hymenium smooth or tuberculate..............2

2. Spores 3.5-4.5 x 2.5-3 um, lagenocystidia lacking or very few.........................*H. pallidula*
2. Spores larger, lagenocystidia few or abundant...................................3

3. Spores 4.5-5.5 x 3.5 um, normally broadest near the apiculus, lagenocystidia abundant...*H. alutaria*
3. Spores 6-7 x 3.75-4.5 um, normally broadest towards the apex, lagenocystidia varying in number but usually few......................*H. propinqua*

HYPHODONTIA ALUTARIA (Burt) John Erikss., Symb.bot.Ups.16(1): 104, 1958.— *Peniophora alutaria* Burt, Ann.Miss.Bot.Gard.12: 332, 1926.— *Peniophora laminata* Burt, Ann.Miss.Bot.Gard.12: 246, 1926.

HOLOTYPUS: U.S.A. Vermont. Little Notch, Bristol. 1902-11-09. E.A. Burt (FH). ISOTYPUS: (H).!

Additional type specimen studied: U.S.A. Vermont. Middlebury. 1896-12-30. E.A. Burt (FH). Holotype of *Peniophora laminata*.

REMARKS. Though close to *H. pallidula* it is as a rule well separated, mainly by its larger spores and the rich occurrence of lagenocystidia.

DISTRIBUTION. Widely distributed in the whole of the northern hemisphere but still not reported from e.g. New Zealand and Australia. Reported from northern India by Rattan (1977) but Hallenberg (1981) did not find it in Iran. One(!) typical specimen has been seen from East Africa (Tanzania), L. Ryvarden No. 9906 (O,GB).

HYPHODONTIA ARGUTA (Fr.) John Erikss., Symb.bot.Ups.16(1): 104, 1958.— *Hydnum argutum* Fr., Syst. myc. I p.424, 1821. — *Odontia arguta* (Fr.) Quel., Ench.fung. p.196, 1886.— *Hydnum fallax* Fr., Syst. myc. I p. 422, 1821.— *Odontia chroospora* Rick ex Rambo, Iheringia Bot. 5:165, 1959.

NEOTYPIFICATION. Two collections in the herbarium of Uppsala have been taken into consideration viz. Fung.exs.suec. No.74 (which is selected as neotype below) and one specimen collected by G. Wahlenberg (Uppsala. Vårdsätra 1819-10-02). According to the label of the last specimen, Fries obviously saw the collection and determinated it as *Hydnum argutum*. In spite of the discrepancy in the diagnosis (see below) this could be taken as a mark of Fries´s opinion of the species.

The collection, however, is not good, especially not as to microscopical details, and therefore not appropriate as a neotype.
The original description in the Systema is somewhat discrepant and the word "candidum", which describes the colour of the fruitbody, has been emphasized by Eriksson and Ryvarden (1976) to be the most important deviation. Other characteristics given in the diagnosis could well be applicable to the fungus nowadays named *Hyphodontia arguta*.

Fries diagnosis: *effusum, tomentosum, candidum, aculeis obliquis acutis serratis*.
Subiculum tenue, irregulariter effusum, adnatum, constanter absque ambitu sterili byssino, quia subiculum oriri videtur tantum e basibus aculeorum villosis connexis. Aculei sub lente examinandi, concrescentes, inaequales, ad latera minute denticulati, longiusculi. Ad ligna & cortices Betulae. Aut. (v.v.).

NEOTYPUS (designated here): SWEDEN. Uppland. Bondkyrka par., Vårdsätra, on bark and wood of decaying, fallen trunks of frondose trees (*Salix*, *Ulmus*). 1932-09-08. Seth Lundell. Fung. exs. suec. No. 74 (UPS).

Additional type specimens studied: SOUTH AMERICA. Brazil. S. Leopoldo. 1934. Rick No.2003 (PACA). Holotype of *Odontia chroospora*. One collection in herb. (E) with Fries own handwriting on the label "*Hydnum fallax* S.M.". NEOTYPUS (designated here) of *Hydnum fallax* Fr.This collection was determined by John Eriksson in 1975 with following comments on the label "numerous spores and basidia, typical lagenocystidia not seen". Though poorly preserved there is no doubt that this specimen represents *H. arguta*.

REMARKS. *Hyphodontia arguta* is easily recognized and quite homogeneous. Microscopically it is similar to *H.alutaria* but is odontioid.

DISTRIBUTION. It is widespread in Europe, Asia, North America, and according to Ryvarden´s collections, fairly common in East Africa. In South America from Brazil only. It is further reported from Australia by Nikolajeva (1961) but no specimens have been seen by me and the species was not mentioned by Cunningham (1963).

HYPHODONTIA PALLIDULA (Bres.) John Erikss., Symb.bot.Ups. 16(1):104, 1958.— *Gonatobotrys pallidula* Bres., Ann. Mycol. 1(1):127, 1903.— *Gloeocystidium pallidulum* (Bres.) Höhn.& Litsch., Sitzber.Akad.Wiss.wien, Math.-nat.Kl.117(1):1096, (16), 1908 (Oct.); Österr.Bot.Zeitschr. 58:471, 1908 (Dec.). — *Peniophora pallidula* (Bres.) Bres. in Bourd.& Galz., Soc. Mycol.Fr.Bull.28:390, 1913.— *Gloeocystidium oleosum* Höhn.& Litsch., Sitzber.Akad.Wiss.Wien, Math.-nat.Kl.116(1):827, (89), 1907.— *Hyphodontia pallidula* var. *alutarioidea* Parm., Consp.syst.cort.p.214, 1968.

HOLOTYPUS: POLAND. Ad truncos Betulae et Pini, leg. Eichler (FH).!

Additional type specimen studied: U.S.S.R. Krasnoiarsk, distr.Ienisseisk, Koltshim. In abieteto ad caudicem arboris coniferae prolapsum. 1956-08-14. E. Parmasto No. 7080 (TU). Holotype of H. pallidula var. alutarioidea.

REMARKS. Similar to H. alutaria and to H. propinqua but readily separated from both by its smaller spores, shorter septocystidia and basidia. Now and then lagenocystidia can be found but they are as a rule few or in many specimens totally lacking.

DISTRIBUTION. Similar to that of H. alutaria but, judging from collections seen, more common, especially in North Europe and North America. Not known from Africa or from the rest of the southern hemisphere.

HYPHODONTIA PROPINQUA Hjortst. spec.nov.

Species Hyphodontiae alutariae affinis sed sporis majoribus et leviter obliquis, circiter 6-7 x 4-4.5 um; cystidiis paulo latioribus, 5-7 um latis.

HOLOTYPUS: AFRICA. TANZANIA. Morogoro Prov. Morogoro distr., Uluguri Mts. Morning Side Res. sta. c. 5 km S. of Morogoro, alt. c. 1500-2100 m. 1973-02-21/26. L. Ryvarden No. 11047 (O). ISOTYPUS: in herb. (GB). PARATYPI: AFRICA. MALAWI. Southern Prov. Thyolo distr., Maminkweya estate alt. 1100 m. 1973-03-03/04. L. Ryvarden No. 11159/A (O). ASIA. INDIA. Darjeeling (W. Bengal), on angiosperm. 1980-08-21. G.S. Dhingra No. 19267 (PAN, GB). NEPAL. Gandaki Prov. Chomro. Anapurna trek, alt. 2000 m. 1979-11-03. L. Ryvarden No. 18766, 18779, and 18782; Ghorapani, alt. 2600 m. 1979-10-30. L. Ryvarden No. 18746 (all in herb O and GB).

Fruitbody resupinate, effuse, cloosely adnate, greyish to pale cream-coloured or ochraceous; hymenium smooth or sometimes slightly tuberculate; margin thinning out, usually as a pruinose zone.
Hyphal system monomitic with the subiculum thin, composed of fairly thick-walled, hyaline and uniform hyphae, 2-3.5 um wide, richly branched and with clamps, with cyanophilous walls. Subhymenial hyphae thin-walled, 2-3 um wide, without or with slight cyanophilous reaction, with clamps.
Cystidia of two kinds: 1) numerous projecting septocystidia, generally with several septa and clamps, with thickened and cyanophilous walls, slightly constricted and apically with resinous encrustation, 50-90(-120) x 5-7 um; 2) lagenocystidia, usually few but as a rule easily recognized, about 30-40 um long and strongly encrusted at the subulate apex.
Basidia subclavate, suburniform, ordinarily with 4 sterigmata, 15-18(-25) x 4.5-5.5 um.
Spores obliquely ellipsoid and in most cases broader towards the apex, smooth, thin-walled, when fully developed 6-7 x 3.75-4.5(-5) um, inamyloid, acyanophilous.

REMARKS. This species resembles H. alutaria but differs from it by larger spores which also are more obliquely ellipsoid. The number of lagenocystidia vary but they seem to be more infrequent than in specimens of H. alutaria.

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MYCOTAXON

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STUDIES IN
TROPICAL CORTICIACEAE (BASIDIOMYCETES) V

Specimens from East Africa, collected by L. Ryvarden

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SUMMARY

The author has investigated a rich material of corticiaceous fungi collected by L. Ryvarden during excursions in 1970 and 1973. The present paper is a part of an account of the species found in East African mountains and the species are, with few exceptions, treated alphabetically. Two new genera are described: Amethicium and Cystidiodontia with the types A. rimosum Hjortst. and Hydnum artocreas Berk. & Curt. ex Cooke respectively. The following species are described as new: Amethicium rimosum, Amylocorticium africanum, Botryohypochnus anomalus, Candelabrochaete verruculosa, and Ceraceomyces cremeo-ochraceus. Two new combinations are proposed viz.: Cylindrobasidium torrendii with the basionym Peniophora torrendii Bres. and Cystidiodontia artocreas.

LIST OF THE LOCALITIES

To shorten the specimens list under each species, the localities have been described separately. All collection-numbers are those of Ryvarden if nothing else has been indicated, and the parantheses accord to the following list.

1. Ethiopia. Asella, western slope of Mount Chilalu, alt.c. 2500-2800 m. 1973-01-06.
2. Ethiopia. Arussi Prov., Munessa Forest east of Lake Langano, alt.c. 1800 m. 1973-01-10.
3. Ethiopia. Arussi Prov., Wondo Genet, 12 km south-east of Shashemene, alt.c. 1900 m. 1973-01-08/09.
4. Kenya. Coast Prov., Kwale Distr., Shimba Hills, Makadara Forest, alt.c. 400 m. 1973-02-14.

4/B. Kenya. Coast Prov., Kilifi Distr., Mida Creek, Mida, alt. less than 10 m. 1970-01-10.
5. Kenya. Eastern Prov., Aberdare Mounts., Kimakia Forest Station, alt.c. 2200-2400 m. 1973-01-16/18.
6. Kenya. Eastern Prov., Meru Distr., Mount Kenya north-east slope, Chigora track, alt.c. 1900-2200 m. 1973-01-31/1973-02-01.
7. Kenya. Eastern Prov., Nyeri Distr., Mount Kenya south slope, Regati Forest Station, alt.c. 2200-2300m. 1973-02-03.
8. Kenya. Central Prov., Mount Elgon, Suam Forest Station, alt.c. 2100 m. 1973-01-23/24.
9. Kenya. Central Prov., Mount Elgon, S. of Suam River, valley to Kapchalwa Gate, alt.c. 2500-3100 m. 1973-01-24.
9/B. Kenya. Nairobi National Park, Athi River. 1970-01-25.
10. Kenya. Western Prov., Kakamega Forest, 13 km ESE of Kakamega, alt.c. 1500 m. 1973-01-25/27.
10/BKenya. Western Prov., Kakamega Forest, near Yala River, 5-7 km S. of Forest Station, alt.1500-1700 m. 1970-01-21.
11. Malawi. Southern Prov., Mulanje Distr., Mulanje Mounts., Lichenya Plateau, alt.c. 1800-2000 m. 1973-03-9/10.
12. Malawi. Southern Prov., Mulanje Distr., Mulanje Mounts., Likabula Valley, alt.c. 900-1600 m. 1973-03-11/12.
13. Malawi. Southern Prov., Thyolo Distr., Naminkweya estate, alt.c. 1100 m. 1973-03-03/04.
14. Malawi. Southern Prov., Thyolo Distr., Thyolo Mounts., alt.c. 1100-1400 m. 1973-03-13.
15. Malawi. Southern Prov., Zomba Distr., Zomba Plateau, alt.c. 1500-1700 m. 1973-03-06/07.
16. Tanzania. Arusha Prov., Arusha National Park, Lake Kusare-Ngurdoto Crater, alt.c. 1500-1700 m. 1973-02-07/09.
17. Tanzania. Arusha Prov., Arusha National Park, Mount Meru east slope, road to the crater, alt.c. 1800-2300 m. 1973-02-08.
18. Tanzania. Kilimanjaro Prov., Mount Kilimanjaro south slope above Mweka, alt.c. 1800-2300 m. 1973-02-12.
19. Tanzania. Kilimanjaro Prov., Mount Kilimanjaro west slope, W. Kilimanjaro Forest Station, alt.c. 1800. 1973-02-10/11.
20. Tanzania. Morogoro Prov., Morogoro Distr., Uluguri Mounts., Morning Side Res. Station, c.5 km south of Morogoro, alt.c. 1500-2100 m. 1973-02-24/26.
21. Tanzania. Tanga Prov., Lushoto Distr., Usambara Mounts., Magamba, c. 4 km north of Lushoto, alt.c. 1600-2000 m. 1973-02-21/22.
22. Tanzania. Tanga Prov., Tanga Distr., Usambara Mounts., Amani, alt.c. 800-1000 m. 1973-02-18/19.

ALEUROCYSTIS HABGALLAE (Berk.& Br.) G.H. Cunn., Trans. Royal. Soc. New. Zeal. 84:235, 1956.

The fungus is discomycete-like and the important microscopical features are the encrusted cystidia (metuloids), paraphysoid hyphae, dendrohyphidia, and large thick-walled spores. The gelatinized hyphae are characteristic and make the fruitbody horny when dry. For good description and its general distribution, see Cunningham 1963.

SPECIMEN EXAMINED: Malawi (11), 11355.

ALEURODISCUS aff. MIRABILIS (Berk.& Curt.) Höhn., Sitzber. Akad. Wiss. Wien, Math.-nat. Kl. 118:818, 1909.

Two specimens which evidently are dimitic are in spite of thus referred to this taxon. The subiculum is composed of intertwined, somewhat thick-walled and sparsely branched hyphae. Other characteristics are the clamped subhymenial hyphae, four-sterigmate basidia, often up to 80-100 um and 20-25 um broad, and with strongly amyloid and echinulate spores, about 25 x 17-20 um. Moniliform cystidia are present, evidently without aldehyde reaction, besides acanthophyses.
Another species which seems to be close to this taxon is *A. australiensis* Wakef. (Kew.Bull.misc.inf. p.208, 1918).

SPECIMENS EXAMINED: Kenya (7), 9804. Tanzania (18), 10290.

AMETHICIUM Hjortst. gen. nov.

Fructificatio resupinata, effusa, adnata, levis, mediocriter mollis, in typo distincte violacea; systema hyphale dimiticum, hyphis basalibus intertextis, ramosis, tenuitunicatis vel crassiusculis, indextrinoidibus, fibulis nullis, hyphis subhymenialibus confertis, tenuitunicatis, fibulatis; cystidia desunt; basidia plus minus clavata, mediocriter constricta, terminalia, 4 sterigmatibus, sporis tenuitunicatis, levibus, hyalinis, in typo parvis (3.5-4 x 1.75-2 um), inamyloidibus, indextrinoidibus.

TYPUS GENERIS: *Amethicium rimosum* Hjortst.

Fruitbody resupinate, effuse, adnate, smooth, moderately soft, in the type species bluish or purplish. *Hyphal system* dimitic. Basal hyphae intricately interwoven into a dense tissue, similar to those generally designated as binding hyphae, thin to moderately thick-walled, frequently branched, simple septate, indextrinoid. Subhymenial hyphae densely arranged, short-celled, thin-walled, with clamps. *Cystidia* absent. *Basidia* terminal, more or less clavate, fairly small, with 4 sterigmata. *Spores* thin-walled, smooth, hyaline, in the type small (3.5-4 x 1.75-2 um), inamyloid, indextrinoid.

AMETHICIUM RIMOSUM Hjortst. spec. nov. Fig. 1.

Fructificatio resupinata, effusa, valde adnata, circiter 200-300 um crassa, hymenio distincte violaceo vel purpureo, rimoso; systema hyphale dimiticum, hyphis basalibus crassiusculis, hyalinis, ramosis, plus minus isodiametris, intertextis, indextrinoidibus, 2.5-4.5 um latis, fibulis nullis, hyphis subhymenialibus confertis, tenuitunicatis, 4-5 um latis, fibulatis; cystidia desunt; basidia plus minus clavata, terminalia, 25 x 4-4.5 um, 4 sterigmatibus, sporis tenuitunicatis, levibus, hyalinis, 3.5-4 x 1.75-2 um, inamyloidibus, indextrinoidibus.

HOLOTYPUS: Tanzania (18), L. Ryvarden 10371 (O).

Fruitbody resupinate, effuse, closely adnate, about 200-300 um thick, with margin not very differentiated, hymenium violaceous or purple or with age greyish but still with a bluish tint, smooth but strongly cracked in irregular pieces, context greyish white, easily visible at the margin or in the hymenial cracks. Hyphal system dimitic. Basal hyphae somewhat irregularly interwoven in a dense tissue, without clamps, with thin-or thickened walls, branching, 2.5-4.5 um wide. Subhymenial hyphae packed together and hardly separable, short-celled, thin-walled, with clamps, 4-5 um wide. Cystidia absent. In some vertical sections hyphal ends have been seen projecting slightly above the basidia. Basidia terminal, more or less clavate, 25 x 4-4.5 um, with 4 sterigmata. Spores ellipsoid, smooth, hyaline, thin-walled, 3.5-4

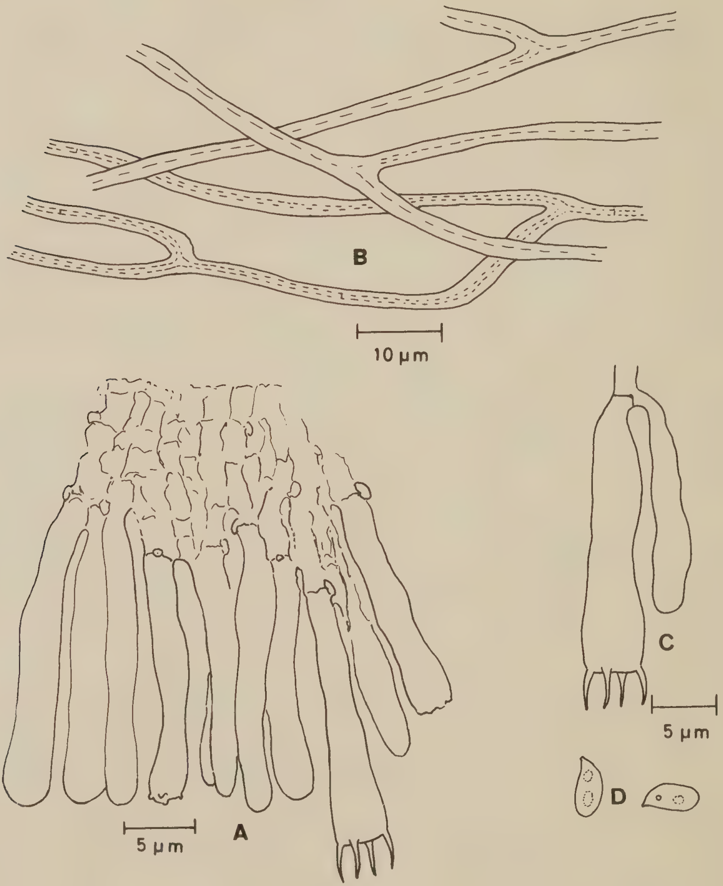


Fig. 1. Amethicium rimosum, a) section through fruitbody b) branched skeletal hyphae c) basidia d) spores.— Typus.

x 1.75-2 um, inamyloid, indextrinoid.

The genus Amethicium is primarily characterized by its purple fruitbody and a dimitic hyphal system with dense skeletal hyphae in the subiculum. The skeletals are intricately interlaced and richly branched, usually at an angle of 45 degrees. They may be described as binding hyphae, as this term is used for polypores. After critical comparision with seemingly related genera such as Fibricium and Fibriciellum, (Eriksson and Ryvarden 1975), and some other, recently described genera from the Tropics, as Dendrodontia and Dextrinodontia, (Hjortstam and Ryvarden 1980 and 1980/b respectively), the genus clearly has an isolated place in the Corticiaceae. The first-mentioned genera have fibre-like skeletals, quite different from that of Amethicium, besides well developed cystidia (in Fibricium), and short-celled subhymenial hyphae (in Fibriciellum). In having dendrohyphidia and brownish skeletals, Dendrodontia is also far from the scope of the described genus, and so is Dextrinodontia which has dextrinoid skeletals and hydnoid fruitbodies.
Amethicium rimosum is easily determined due to its colour, branched basal hyphae, and small, inamyloid and acyanophilous spores.

AMYLOCORTICIUM AFRICANUM Hjortst. spec. nov. Fig. 2.

Differt ab Amylocorticio cebennensi hyphis vesiculis claviformibus modice numerosis instructis, 10-15 x 5 um; colore plus minus atrocremeo; sporis suballantoidibus 5.5-6.5 x 1.5-2 um.

HOLOTYPUS: Malawi (11), L. Ryvarden 11346 (O).

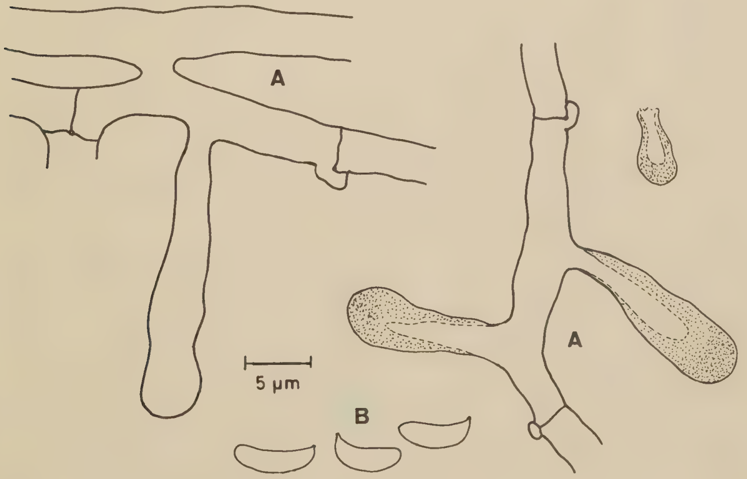


Fig. 2. Amylocorticium africanum, a) hyphae with protuberances b) spores.— Ryvarden 11454.

ISOTYPUS: in herb. (GB).
PARATYPI: Kenya (7), 9862, 9876. Malawi (12), 11436, 11454. Tanzania (18), 10254.

Fruitbody resupinate, effuse, pellicular, more or less pliable, hymenium smooth, dark cream-coloured or becoming brownish. Hyphal system monomitic. Basal hyphae loosely intertwined, with thickened walls, 4-5 um wide. Subhymenial hyphae more densely united. All hyphae with clamps. Cystidia absent but with vesicular protuberances on the hyphae, easily visible in a crush-preparation, 10-15 x 5 um, in KOH strongly refractive, without aldehyde or cyanophilous reaction. Spores suballantoid, thin-walled, hyaline, smooth, 5.5-6.5 x 1.5-2 um, distinctly amyloid.

This new species is closely related to A. cebennense (Bourd.) Pouz. but easily separated by its vesicular protuberances on the hyphae and slightly shorter spores. In A. cebennense the spores are known to vary, but in general they are longer than 7 um.

AMYLOCORTICIUM aff. **SUBSULPHUREUM** (Karst.) Pouz., Česká Mykol. 13(1): 11, 1959.

This species was not found among Ryvarden´s collections but Malençon (1957) reported a form of Odontia alutacea (Fr.) Bourd.& Galz. from Marocco which is better placed near A. subsulphureum. The spores are amyloid and the cystidia are normal for the species with several constrictions. It differs, however, by the hymenium which is slightly odontioid and not smooth as in normal specimens of A. subsulphureum. The specimen is in a poor condition and to clarify its taxonomic disposition more material is needed.

SPECIMEN EXAMINED: Africa. Marocco. Tamrabta. 1952-05-15. No. 2213 (MPU).

BOTRYOBASIDIUM ASPERULUM (Rog.) Boid., Cahiers la Maboké 8(1): 19, 1970. Fig. 3, a-c.

According to the original description by Rogers (1943) the spores are 4.5-5.5 x 3.5-4.5 um (compare Boidin 1970, 4-5.2 x 2.75-3.25 um). In specimens from East Africa the spores vary considerably, mostly from 4 to 7 um, occasionally up to 10-11 um long. This variability might be explained by the number of sterigmata (from 4-8).
With the exception of the verruculose spores B. asperulum is strikingly similar to B. laeve (John Erikss.) Parm. and B. pruinatum (Bres.) John Erikss. The spores of these species are thick-walled and, together with the hyphae, strongly cyanophilous. Besides, the basal hyphae are very wide and with dextrinoid reaction. Apparently these species form a group of their own in Botryobasidium.
Jülich (1979) described Cyanobasidium to accomodate Pellicularia chordulata Rog. and he also included P. asperula in it. In 1982, he described Cyanohypha with P. asperula as the generic type. This later step may be a better solution, but until more facts are added, for example cultural tests, I follow Boidin and Gilles (1982) and retain the species in Botryobasidium. (See also Cyanobasidium below).

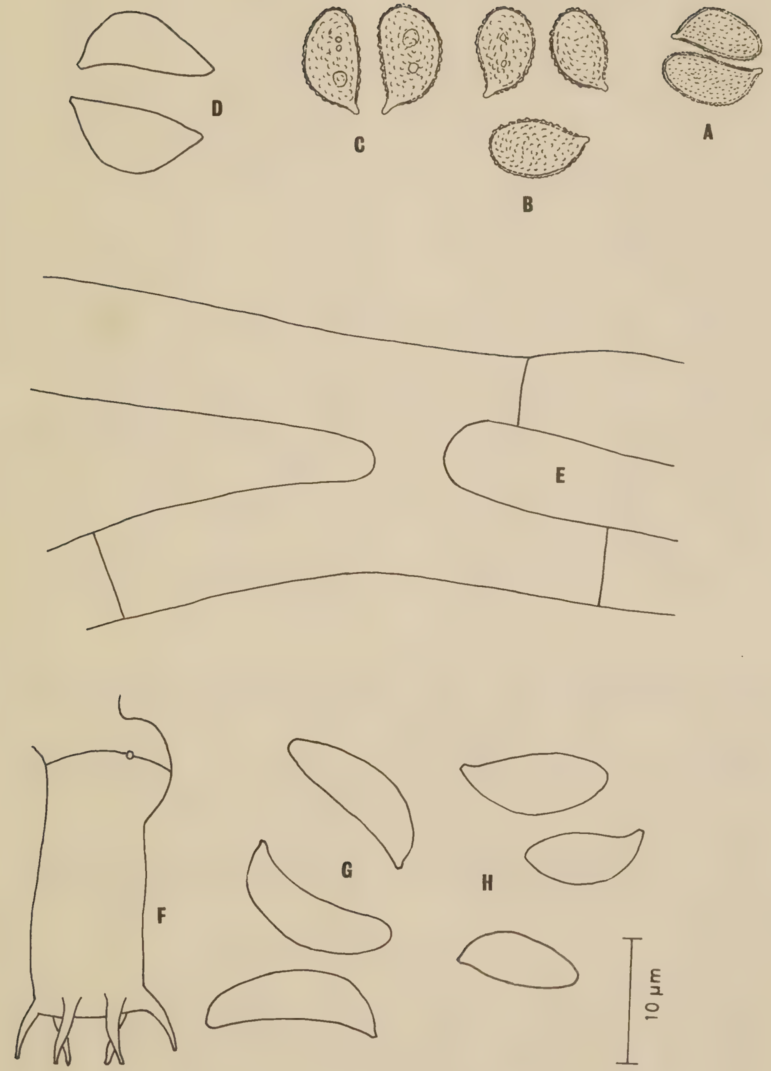


Fig. 3. *Botryobasidium asperulum*, a-c) spores.— Cain 1966-07-05 (a). Ryvarden 11183 (b). Ryvarden 11191 (c). *B. medium*, d) spores e) hypha without clamps f) basidium with six sterigmata.— Ryvarden 10802. *B. danicum*, g) spores.— Ryvarden 11057. *B. vagum*-group, h) spores.— Ryvarden 10301/A.

SPECIMENS EXAMINED: Kenya (7), 9849, 9854, and coll. R.F. Cain 1966-07-05 (TRTC). Malawi (11), 11312, 11327. (13), 11183 and 11191. (15), 11275.

B. BANANISPORUM Boid., Cahiers la Maboké 8(1): 20, 1970.

SPECIMEN EXAMINED: Tanzania (20), 10980.

B. DANICUM Erikss.& Hjortst., Friesia 9:11, 1969.Fig. 3, g.

In the size and shape of the spores, one specimen agrees with this species. Most of the spores were 12-14 x 3.75-4.5 um and slightly bent.

SPECIMEN EXAMINED: Tanzania (20), 11057.

B. MEDIUM John Erikss., Symb. Bot. Ups. 16(1):54, 1958. Fig. 3, d-f.

CONIDIAL STATE: Haplotrichum medium (Hol.-Jech.) Hol.-Jech., Česká Mykol. 30(1):4, 1976.

Both the conidial and the basidial state are represented in the collection. According to Holubová-Jechová (1969) all hyphae are provided with clamps. This is not true for specimens I have seen from North Europe as well as from Africa (for detailed description see Eriksson and Ryvarden, 1973).

SPECIMEN EXAMINED: Tanzania (21), 10802.

B. SUBCORONATUM (Höhn.& Litsch.) Donk, Meded. Ned. Myc. Ver. 18-20:117, 1931.

SPECIMENS EXAMINED: Malawi (15), 11236. Kenya (5), 8966, (7), 9867, (10), 9489 (no spores seen, doubtful). Tanzania (21), 10851.

B. VAGUM — group. Fig. 3, h.

As no conidial states appear it is impossible to determine the collections, and it should be noted that the material is non-uniform and could represent several different taxa.

SPECIMENS EXAMINED: Kenya (6), 9745 and 9747. Malawi (12), 11494, (15), 11247. Tanzania (17), 10024, (18), 10301/A, (9), 10155, (22), 10598, 10628, 10666, and 10676.

BOTRYOHYPOCHNUS ANOMALUS Hjortst. spec. nov. Fig. 4, a-d.

Differt a Botryohypochno bondarcevii sporis aculeatis vel echinulatis et 8-9 um diametro; parietibus crassiusculis, vel distincte crassis.

HOLOTYPUS: Kenya (8), L. Ryvarden 9189 (O).
ISOTYPUS: in herb. (GB).

Fruitbody resupinate, loosely adnate, hypochnoid to slightly pellicular, pale ochraceous. Hyphal system monomitic. Basal hyphae about 9-10 um wide, ramified at right angles, with thickened walls. Subhymenial hyphae similar but thin-walled. All hyphae without clamps. Basidia stout, mostly obovate, 18-25 x 10-12 um, with four sterigmata. Spores more or less distinctly thick-walled, at least when fully mature, echinulate to aculeate, subglobose and normally 8-9 um in diam., pale brown and with distinct apiculus.

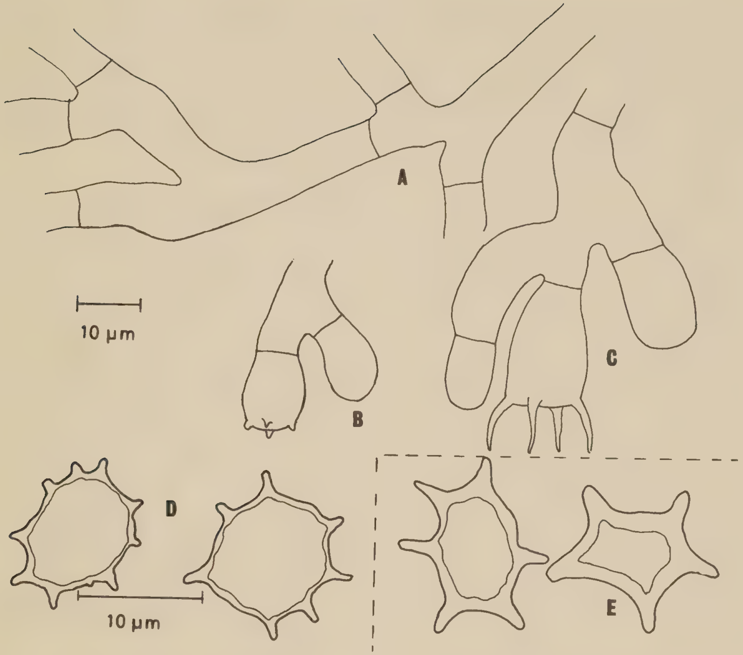


Fig. 4. Botryohypochnus anomalus, a) basal hyphae b,c) basidia d) spores.— Typus. B. bondarcevii, e) spores.— Typus.

This new species is somewhat intermediate between B. bondarcevii Parm. (Fig.4, e) and B. isabellinus (Fr.) John Erikss. The first one has decidedly smaller spores and thicker walls, while the latter has globose spores which are distinctly echinulate. Superficially the genus Tomentellastrum (Thelephoraceae) is closely related to Botryohypochnus, but species of that genus have basidia much more elongated and with a narrow basal part.
In addition to the type-collection, one specimen from North America has been seen (Tennessee. Great Smokey Mts. National Park. 1977-09-08. L. Ryvarden 14195 (O). This specimen is close to the described species but the spores are slightly smaller and the aculei are fewer.

B. BIAPICULATUS (Rog. in Martin) Parm., Eesti NSV Tead. Akad. Toim. Biol. Seer. 14(2):221, 1965. Fig. 5.

HOLOTYPUS: (Pellicularia biapiculata Rog.) Brazil. Sao Leopoldo. Dec. 1939. J. Rick (herb. Univ. Iowa No. 1555!).

Fruitbody resupinate, effuse, thin, somewhat hypochnoid, under a lens discontinuous, pale ochraceous. Hyphal system monomitic. Hyphae loosely interwoven, sparsely to moderate ramified, hyaline, without clamps, about 7-8 um wide, with cyanophilous walls. Cystidia absent. Basidia at first rounded, then obovate to more or less cylindrical, without basal clamp, 15-20 x 8-10 um, with four sterigmata. Spores warted, thick-walled, hyaline, distinctly biapiculate (less lemon-shaped in the material from Africa), usually 8-12 x 5-7 um, incl. apiculus and the elongated apex. In the type-specimen without spore-repetition, but secondary sterigmata occur, though rarely, in all African specimens.

Basically quite similar to Uthatobasidium fusisporum (Schr.) Donk which also was indicated by the author in the original description. B. biapiculatus is, however, immediately separated from that species by its rough spores. Besides, the basidia are more close to that of Botryohypochnus and the sterigmata are not elongate, as they characteristically are in U. fusisporum.
The holotype of Pellicularia biapiculata has been examined. It is well developed and in good condition. The spores are strictly lemon-shaped and no repetition was observed. In the African material, of which no. 11530 is best developed, the spores are more subglobose and not distinctly biapiculate. In all other characteristics, macromorphology, the nature of basidia and hyphae, number and size of the sterigmata, they are so similar that I do not hesitate to use the cited name. Another recently described species is B. hebelomatosporus Boid.& Gilles (1982). It is characterized by its almond-shaped and pale brown spores. As for B. biapiculatus it is assumed to be slightly deviating from the generic concept. For further discussion of the subfamily Botryohypochnoideae see Boidin and Gilles (1982,pag. 301-302).

SPECIMENS EXAMINED: Malawi (14), 11530. Tanzania (17), 10018 and 10026 (both on fruitbodies of Phellinus sp.).

B. ISABELLINUS (Fr.) John Erikss., Sv. Bot. Tidskr., 52(1): 2, 1958.

SPECIMENS EXAMINED: Tanzania (19), 10222. Ethiopia (3), 8781 and 8829. Kenya. Rift Valley Prov., Karisia Hills Maralal. 1972-11-24. D. Taylor 1530 (O).

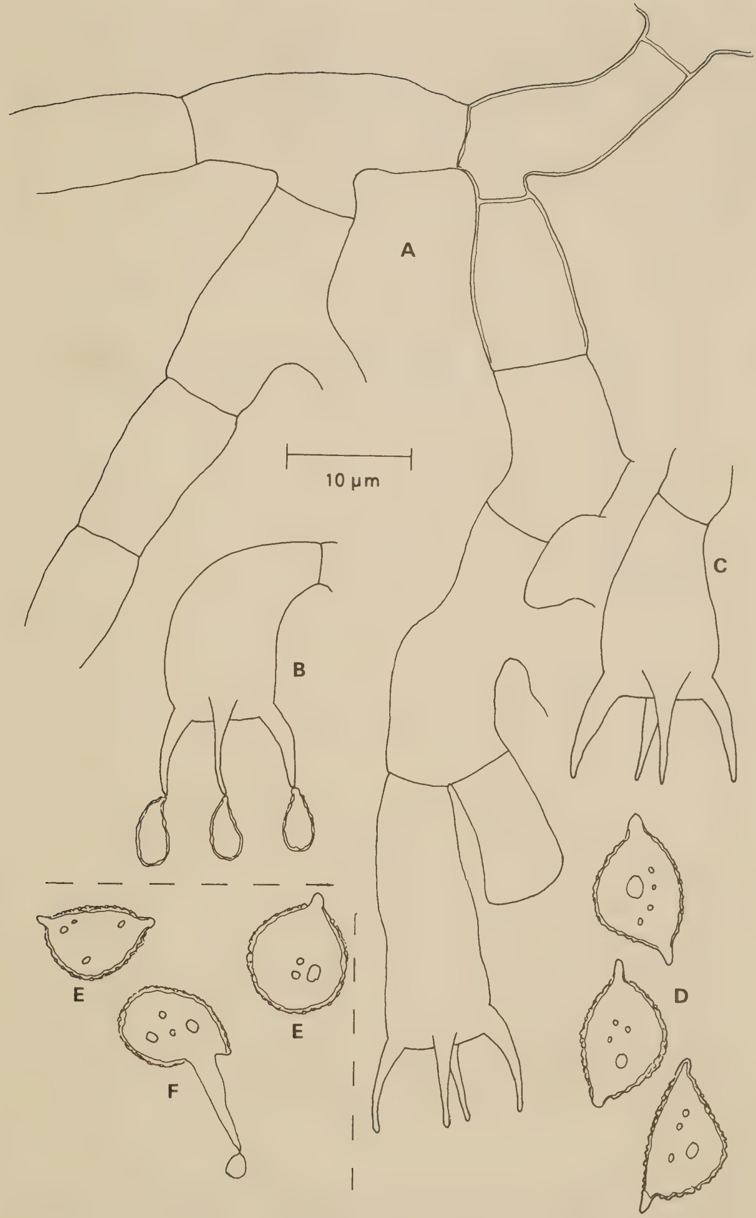
BYSSOMERULIUS Parm., Eesti NSV Tead. Akad. Toim. Biol. Seer. 16(4): 383, 1967.

Phlebia faviformis W.B. Cooke, Los. Ang. Co. Mus., Contrib. in sci. No. 24:4, 1958.

The interpretation of this taxon is somewhat doubtful since the holotype lacks spores, see Ginns (1976) for further information. The African material is near Byssomerulius corium (Fr.) Parm. but well separated from that species, primarily by its smaller spores, without any sigmoid appearance.

SPECIMENS EXAMINED: Kenya (8), 9148, 9179, and 9235, (9), 9293. Tanzania (16), 9917 and 9924, (17), 10065.

Fig. 5. Botryohypochnus biapiculatus, a-c) hyphae and basidia d-f) spores.— a-d) typus e-f) Ryvarden 10018.


A
10 µm
C
B
D
E
E
F

CANDELABROCHAETE VERRUCULOSA Hjortst. spec. nov. Fig. 6, d-g.

Differt a Candelabrochaete africana hymenio verruculoso, aculeis 6-8/mm; sporis distincte ovalibus, 5.5-6 x 3-3.5 um, hyphis plus minus tenuitunicatis, cystidiis indistincte projectis, septatis, doliiformibus, tenuitunicatis vel crassiusculis, interdum clavatis et sine septatis.

HOLOTYPUS: Kenya (5), L. Ryvarden 9056 (O).
ISOTYPUS: in herb. (GB).
PARATYPUS: Malawi (11), 11300/F.

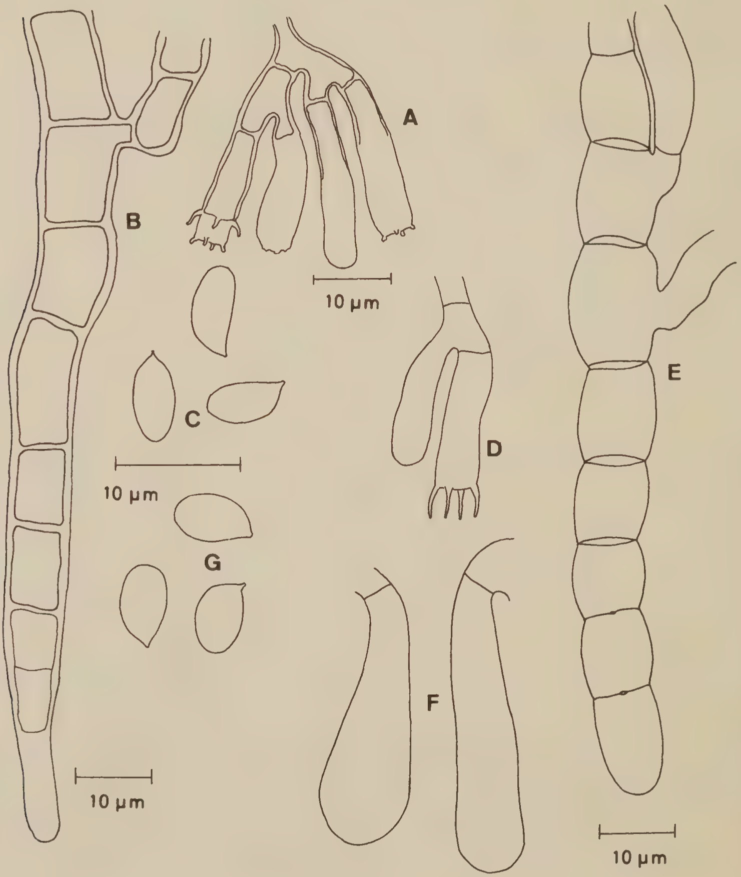


Fig. 6. Candelabrochaete africana, a) basidia b) cystidium c) spores.— Typus. C. verruculosa, d) basidia e) cystidium f) young cystidia g) spores.— Typus.

Fruitbody resupinate, widely effused, adnate, pale brown to more or less reddish, distinctly grandinioid or odontioid with aculei 6-8/mm. *Hyphal system* monomitic. Basal hyphae with thin-or slightly thickened walls, often up to 10 um wide, sometimes barrel-shaped and simulating the cystidia. Subhymenial hyphae narrower, 4.5-6 um wide. All hyphae without clamps. *Cystidia* mostly barrel-shaped, up to 100 um long or more, projecting slightly above the basidia, some clavate, unseptate and embedded, 40-70 um long. *Basidia* short-clavate, 15-20 x 4.5-5 um, with four sterigmata. Now and then linear repetition occurs but is as a rule difficult to observe and less pronounced than in *C. africana* and in the material from North Europe. *Spores* ellipsoid, thin-walled, 5.5-6 x 3-3.25 um (in *africana* 5.5-6.5 x 2.25-3 um), neither amyloid nor cyanophilous.

Similar to *Candelabrochaete africana* Boid. but separated by an odontioid fruitbody, thin-walled hyphae and cystidia, and by slightly broader, ellipsoid spores.
According to Eriksson et al.(1981,Vol. 6) the Norwegian specimen was with some doubt referred to *C. africana*, preferably by its narrower spores and thin-walled cystidia. After that the same taxon has been re-collected by E. Høgholen (more than 150 km SE of the first locality) and it seems clear that the Nordic specimens should be better referred to *C. verruculosa*. Also a specimen from Brazil (*Odontia modesta* Rick ex Rambo, invalid name, see Hjortstam and Ryvarden, 1982) is so close that it could be given the same name.

CERACEOMYCES BOREALIS (Rom.) Erikss.& Ryv., Cort. North Europe Vol. 2:205, 1973.

Microscopically the specimen from Tanzania agrees well with North European ones, but is less folded. The Malawi collection has thick-walled and pale brown basal hyphae. It could be a species of its own but the material is too scanty to be described as a new species.

SPECIMENS EXAMINED: Tanzania (20), 10995. Malawi (14), 11534.

CERACEOMYCES CREMEO-OCHRACEUS Hjortst. spec. nov. Fig. 7.

Fructificatio resupinata, laxe adnata, in sicco distincte membranacea, cremeo-alba vel subochracea, margine simili vel leviter fibroso; systemate hyphali monomitico, hyphis basalibus tenuitunicatis, rectis et uniformibus, nunullis flavidis incrassatis, fibulatis, circiter 3-4 um latis, hyphis subhymenialibus irregularibus, item distinctis sed cellulis brevibus, fibulatis; cystidia sparsissima, subclavata, incrustata, apicem versus leviter dilatata, subcapitata, 30-40 x 5-8 um; basidia subclavata, aliquantum elongata, 25-30 x 4.5-5.5 um, 4 sterigmatibus, sporis tenuitunicatis, levibus, subglobosis vel ellipsoidibus, 6-6.5(-7) x 3.5-3.75(-4) um, neque amyloidibus et cyanophilis neque dextrinoidibus.

HOLOTYPUS: Malawi (11), L. Ryvarden 11408 (O).
ISOTYPUS: in herb. (GB).
PARATYPUS: Kenya (5), 9077.

Fruitbody resupinate, effuse, loosely adnate, pellicular to distinctly membranaceous, easily separable, more or less cerececeous, cream to pale ochraceous, margin abrupt or slightly fibrillose. Hyphal system monomitic. Subiculum thin, cobwebby with hyphae 3-4 um wide, thin-walled, some heavily encrusted. Subhymenial hyphae somewhat narrower, short-celled, generally smooth. All hyphae with clamps. Cystidia few, but easily recognized owing to their yellow encrustation, widened towards the apex or slightly capitate, 30-40 x 5-8 um. Basidia subclavate, somewhat elongate, indistinctly constricted, 25-30 x 4.5-5.5 um, with four sterigmata. Spores subglobose to ellipsoid, thin-walled, hyaline, smooth, 6-6.5(-7) x 3.5-3.75(-4) um, with distinct apiculus, inamyloid, acyano-

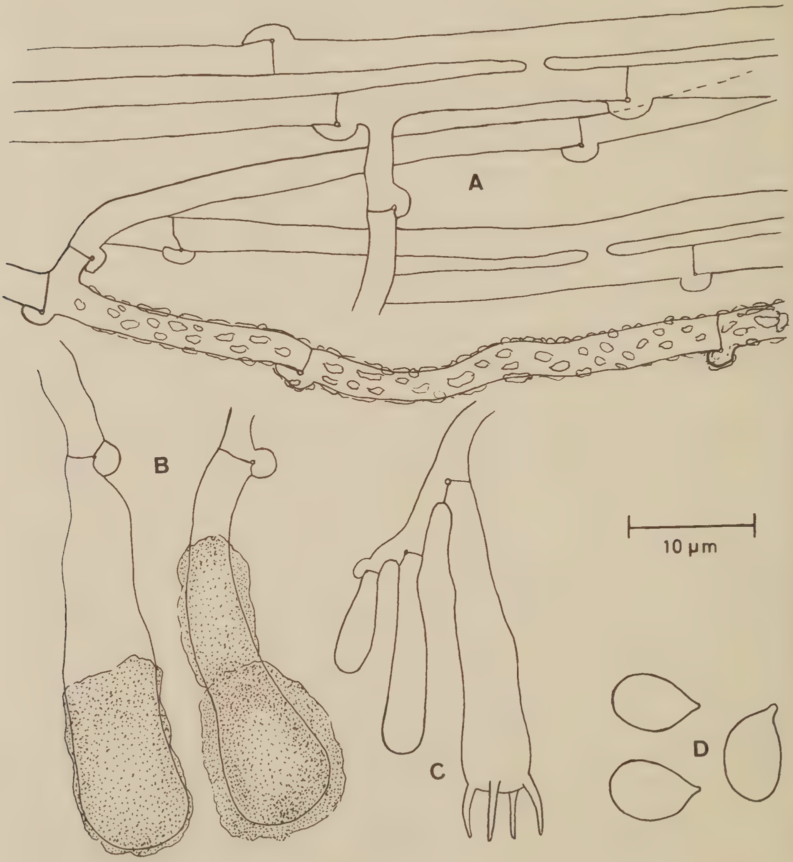


Fig. 7. Cereceomyces cremeo-ochraceus, a) hyphae b) cystidia c) basidia d) spores.— Typus.

philous, and non-dextrinoid.

This species is fairly close to *Ceraceomyces violascens* (Fr.) Jülich, preferably in the spore morphology and in the nature of subicular hyphae. The hyphae of this species are mostly broader, often up to 8 um wide. The spores are also smaller. The big difference is the presence of the cystidia with yellow encrustation and somewhat capitate apices, lacking in *C. violascens*.

CEROCORTICIUM MOLLE (Berk.& Curt.) Jülich, Persoonia 8(2): 219, 1975. Syn. *Cerocorticium bogoriense* P. Henn., O. Warburg, Monsunia 1:139, 1899, fide Jülich.— *Cerocorticium tjibodense* P. Henn., loc. cit., fide Jülich.

The genus *Cerocorticium* is typified with *C. bogoriense*, which in some respects is similar to *Phlebia* because of its dense hyphal texture and, when dried, semihyaline and horny fruitbodies. However, the spores and the basidia are larger than in most species of *Phlebia*.
The species is well characterized by its cream-yellow fruitbody, large, ellipsoid spores with oily inclusions in the protoplasm, and with numerous paraphysoids, penetrating the hymenial layer and project above the basidia.
The similarity to such genera as *Globulicium* and *Uncobasidium* is only a matter of superficiality (see Jülich and Stalpers 1980). The first genus, typified with *Corticium hiemale* Laurila, is characterized by globose and relatively large spores, presence of paraphysoid hyphae, but with a texture quite different from that of *Cerocorticium* (see Hjortstam 1973 and Eriksson and Ryvarden 1975 Vol.3). It is composed of loosely interwoven and thin-walled hyphae, not agglutinated as in both *Cerocorticium* and *Phlebia*. The latter genus, *Uncobasidium*, was described to accomodate species with hooked pleurobasidia, a unique characteristic in *Corticiaceae* (see Hjortstam and Ryvarden 1978). Both these genera have evidently nothing in common with neither *Cerocorticium* nor *Phlebia*.

SPECIMENS EXAMINED: Tanzania (16), 9983, (21), 10816. Malawi (12), 11500, (13), 11196. Kenya (4/B), 5058, (10/B), 5488.

CRISTINIA HELVETICA (Pers.) Parm., Consp.Syst. Cort. p. 48, 1968.

SPECIMEN EXAMINED: Tanzania (19), 10165.

CYANOBASIDIUM CHORDULATUM (Rog.) Jülich, Persoonia 10(3):328, 1979. Fig. 8.

Fruitbody resupinate, loosely adnate, thin, pellicular to membranaceous, under a lens porulose or finely granulose, cream to pale ochraceous. *Hyphal system* monomitic. Subicular strands occur, often abundantly, consisting of thin-walled, loosely interwoven hyphae, 4-5 um wide, rarely branched and usually without clamps, other hyphae in the subiculum ramified, mostly at right angles, about 5-7 um wide, with scattered clamps. Subhymenial hyphae short-celled, usually with clamps but some simple septa occur. All hyphae cyanophilous but indextrinoid. *Cystidia* absent. *Basidia* fairly stout, protoplasm granular (with cyanophilous globules), with four sterigmata, 14-20 x 5-8 um. *Spores* globose or indistinctly subglobose, pale brown (?), with a prominent apiculus, echinulate or slightly warted, with thickened walls, strongly cyanophilous but not dextrinoid nor amyloid, about 5 um in diam.

Basidia with cyanophilous granular contents distinguishes this species from both *Botryobasidium* and *Botryohypochnus*. Judging from the description and figure of *Botryobasidium alutaceum* Boid. (1970) this is a species close to *C. chordulatum* but no authentic material has been studied.

SPECIMEN EXAMINED: Kenya (4), 10424 good material.

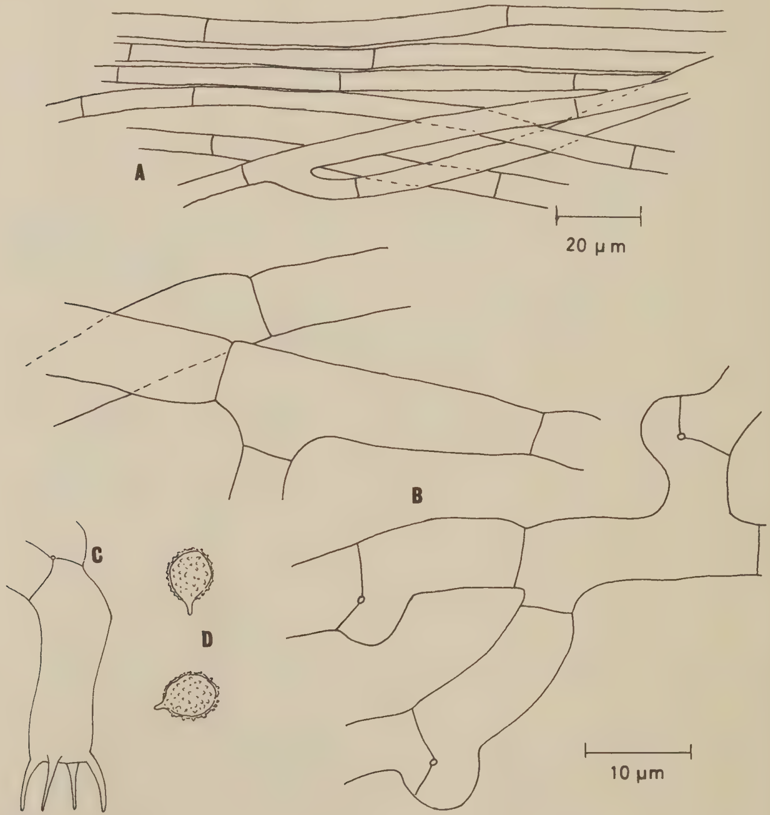


Fig. 8. *Cyanobasidium chordulatum*, a) hyphal strands b) subicular hyphae c) basidium with four sterigmata d) spores. — DPR 946, typus.

CYLINDROBASIDIUM TORRENDII (Bres. in Torrend) Hjortst. comb. nov.— Basionym: Peniophora torrendii Bres. in Torrend, Broteria, Seer. Bot. 11(2):77, 1913.— Syn.: Peniophora albula Atk.& Burt, Ann. Miss. Bot. Gard. 12:231, 1925.— Cylindrobasidium albulum (Atk.& Burt) Erikss.& Hjortst., Cort. North Europe Vol.4:569, 1976.— Corticium gloeosporum Talbot, Bothalia 4:940, 1948!.

HOLOTYPUS: ad ligna Fraxini, Portugal,leg. Torrend (S)!

This species is quite similar to C. evolvens (Fr.) Jülich but distinguishable by its smaller spores and thinner, totally resupinate fruitbody.

SPECIMENS EXAMINED: Malawi (12), 11510. Tanzania (20), 11007. Canada. J. Macoun No. 5 (holotype of P. albula, FH). U.S.A. Tennessee. Great Smokey Mts. National Park 1977-09-08. L.Ryvarden 14164 and 14222 (O).

CYSTIDIODONTIA Hjortst. gen. nov.

Fructificatio resupinata, effusa, arcte adnata, crustacea, hymenio grandinioide vel odontioide, plerumque fragili, systemate hyphali dimitico, dendrohyphidiis saepe instructo, hyphis skeleticis plus minus dextrinoidibus, fibulis nullis, hyphis subhymenialibus fibulatis; gloeocystidia facile observata; basidia subclavata, plerumque constricta, 4 sterigmatibus, sporis crassitunicatis, incoloratis, non amyloidibus, cyanophilis, in typo plus minus subglobosis.

TYPUS GENERIS: Hydnum artocreas Berk.& Curt.ex Cooke

Cystidiodontia is separated from Cystostereum Pouz. by thick-walled spores, presence of dendrohyphidia and dextrinoid tissue. The genus Crustomyces Jülich (generic type, Odontia subabrupta Bourd.& Galz.) is superficially similar but separatedinter alia by thin-walled spores and indextrinoid tissue. The genus Cystidiodontia is so far monotypic.

CYSTIDIODONTIA ARTOCREAS (Berk.& Curt.ex Cooke) Hjortst. comb. nov. — Basionym: Hydnum artocreas Berk.& Curt.ex Cooke, Grevillea 21:1, 1891.

HOLOTYPUS: Venezuela 1879 Berk.& Curt. No. 139 (K)!

This is one of the most common species collected by Ryvarden and easily determined due to its odontioid fruitbody, dextrinoid reaction, and thick-walled spores. For further information, see Hallenberg and Ryvarden (1975) who have treated the species under the subgenus Dendrohyphidium. Gilbertson (1965) indicated Grandinia accumulata Berk.&Curt. as a prior name for this taxon. I have studied the holotype (Cuba, No. 228, herb. Berk. 1879, K) but I am not convinced that it is conspecific with H. artocreas. The type is poor and no spores were found. In addition, the type of Hypochnicium grandinioides Ryv. (1978) has been examined and this is the same as the taxon dealt with here.

SPECIMENS EXAMINED: Ethiopia (3), 8813. Kenya (10), 9392. Tanzania (19), 10233 (very good material). Additional material were listed by Hallenberg and Ryvarden (loc.cit).

DACRYOBOLUS SUDANS (Fr.) Fr., Summa Veg. Scand. 2:404, 1849.

Most specimens are more distinctly odontioid than usual and the aculei are often up to 1-1.5 mm long. Microscopically it still fits the concept of the species.

SPECIMENS EXAMINED: Kenya. Rift Valley Prov., Karisia Hills. 1972-11-24. D. Taylor 1188 (O). Kenya (6), 9636, (8), 9164. Malawi (11), 11307/C. Tanzania (17), 10039, (20), 10999, (21), 10819.

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MYCOTAXON

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SANCTIONED EPITHETS, SANCTIONED NAMES: ERRATA AND AMPLIFICATION

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On page 343 of my recent article (Korf, 1983) I blundered in a way that may certainly confuse readers. In the second paragraph of the section "The 1950-1981 Dilemma: Author Citations," just before examples (1), (2), and (3), I incorrectly indicated that these three author citations were permitted "Prior to 1959 ...." I should have written "Between 1910 and 1950 ...."

In the paragraph immediately following these examples two sentences, beginning with "In the 1959 and 1964 Codes ...," also are wrong for the particular species name cited, **Peziza araneosa.** They would have been correct for any species name that had **not** been taken up by any author between 1 Jan 1821 and when Fries used the name in the **Systema.** Since the cited name **was** treated numerous times during that nearly 2-year period (see pg. 344 of my article), **none** of those three citatations would have been approved after 1950.

In discussions with colleagues who have read that recent paper, I have been surprized to find how many had been previously unaware that even though a name had been adopted by Fries in the **Systema** and thus had protected status under the Codes from 1950-1981, those names in volumes 2 and 3 in nearly all cases lost all reference to Fries when correctly cited. The "ex Fr." that they had been used to seeing was wrong and should have been replaced by "ex Gray," "ex Mérat," "ex Hook.," etc., the author of choice being the **first** to use the name (or epithet in any combination) after 1 Jan. 1821. I perhaps did not emphasize that point sufficiently in the paper. I summarize here the author citations approved by the Codes during five time periods for **Peziza araneosa** Bull. 1791:

Author citations permitted from 1910 to 1950

(1) **Peziza araneosa** [Bull.] Fr.

(2) **Peziza araneosa** Bull. ex Fr.

(3) **Peziza araneosa** Fr.

Author citations permitted from 1950 to 1959

(4a) **Peziza araneosa** [Bull.] St.-Amans

(4) **Peziza araneosa** Bull. ex St.-Amans

(5a) **Peziza araneosa** [Bull.] Nocca & Balb.

(5) **Peziza araneosa** Bull. ex Nocca & Balb.

(6) **Peziza araneosa** St.-Amans

(7) **Peziza araneosa** Nocca & Balb.

Author citations permitted from 1959 to 1969

(4a) **Peziza araneosa** [Bull.] St.-Amans

(5a) **Peziza araneosa** [Bull.] Nocca & Balb.

(6) **Peziza araneosa** St.-Amans

(7) **Peziza araneosa** Nocca & Balb.

Author citations permitted from 1969 to 1981

(4) **Peziza araneosa** Bull. ex St.-Amans

(5) **Peziza araneosa** Bull. ex Nocca & Balb.

(6) **Peziza araneosa** St.-Amans

(7) **Peziza araneosa** Nocca & Balb.

Author citations permitted from 1981-ff. (new Code)

(10) **Peziza araneosa** Bull.

(11) **Peziza araneosa** Bull. : Fr.

I am indebted to Dr. Amy Y. Rossman for calling the errors to my attention.

REFERENCE CITED

KORF, R. P. 1983. Sanctioned epithets, sanctioned names, and cardinal principles in ": Pers." and ": Fr." citations. Mycotaxon **16**: 341-352.

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HELOTIUM ONCE AGAIN

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In a recent paper Redhead (1982) has argued for the resurrection of *Helotium* Tode 1791. This name was coined for a couple of omphaloid agarics but as originally conceived it soon sunk into oblivion and has not been in use for about 150 years. It is up to the agaricologists to decide whether such a revival is desirable but I wish to comment upon the status of *Helotium* Pers. 1801.

As is well known, i.a. by Donk's thorough analysis (1962), Persoon transformed Tode's *Helotium* into a genus of Discomycetes. According to Donk, however, *Helotium* Pers., was not validated by Fries in Systema Mycologicum and is thus an illegitimate younger homonym of *Helotium* Tode ex Leman 1821. In a short notice (Holm 1976) I drew attention to the overlooked fact that Fries actually had validated *Helotium* Pers. by a reference in a foot-note in Syst. Mycol. 1:500, or, in the new language of the Sydney Code, that Fries had sanctioned the name.

Now, however, Redhead has disapproved of this sanctioning: "Surely the mention of a name in a foot-note cannot be considered sufficient even if the name can be traced to Persoon... We cannot be certain what Fries (1821) intended or that he would even place any species in it and therefore must treat the mention of the name as incidental, of debatable acceptance, not supported by named species, and not indexed. This...should be taken as insufficient for sanctioning purposes" (Redhead 1982 p. 2003).

A few remarks seem appropriate. First: The cited words reflect an exaggerated - and one could well say unfortunately exaggerated - idea of the formal demands that can be made upon the old works with their many nomenclatural oddities. Actually, a name cannot be disqualified for the reason that it was published in a foot-note, nor is a generic name outlawed because no species were mentioned. Second: The gist of Redhead's argumentation is his assertion that Fries' real intentions in 1821 remain doubtful. I cannot agree. The humble foot-note was not Fries' only reference to *Helotium* Pers. in 1821. It is significative that Fries included *Helotium* among the Discomycetes ('Hymenomycetes Cupulati') in his generic survey in Syst. Mycol. 1, p. 2. In that place Fries omitted the author designation, and solely for that reason *Helotium* Pers. cannot be considered as sanctioned on p. 2. But the meaning is quite clear and the necessary reference to Persoon is provided by the famous foot-note. So, with a slight travesty of Redhead's wording, "we can be certain what Fries (1821) intended".

It is true that Fries later changed his mind, as he not seldom did, and in 1832 accepted *Helotium* Tode. That means that Fries sanctioned *Helotium* twice, first *Helotium* Pers. in 1821, then *Helotium* Tode in 1832. This case is not unique but is hardly covered by the rules. It seems reasonable to me to regard *Helotium* Tode:Fr. as a later homonym of *Helotium* Pers.:Fr.

Probably these nomenclatural subtleties seem like quibbling but they may be of interest to agaricologists unwilling to accept *Helotium* Tode.

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NOTES ON CORTICIACEAE (BASIDIOMYCETES) XII

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SUMMARY

Two new species are described based on collections from Finland, Norway, and Sweden: Sistotrema intermedium and Xenasmatella romellii. The holotypes of Corticium eximum Jacks., Corticium macounii Burt, Sphaerobasidium subinvisibile Liberta, Xenasma californicum Liberta, and Xenasma gaspesicum Liberta have been studied. S. subinvisibile has been found to possess cystidia, and the two latter species, of which X. gaspesicum is new to Europe, are placed in Xenasmatella Oberw.

CLAVULICIUM MACOUNII (Burt) Erikss.& Boid.ex Parm. Consp. syst. Cort. p. 165, 1968.— Corticium macounii Burt, Ann. Miss. Bot. Gard. 13:256, 1926.

HOLOTYPUS: Canada. Quebec. Hull. 1898-10-17. J. Macoun 368, (FH).

Pouzar recently (1982) introduced the name Corticium vinososcabens Burt for this taxon, apparently without having seen the type-material of Corticium macounii Burt. He based his opinion on Liberta (1969) and on the type-specimen of Corticium maculatum Litsch. All these species were carefully studied by Rogers and Jackson (1943) and both C. vinososcabens and C. maculatum were at that time synonymized with C. macounii. (For additional information concerning other specimens mentioned by Burt in the original description of the species see Rogers and Jackson loc.cit.). I can not agree with Pouzar´s opinion because the holotype of C. macounii corresponds perfectly with the contemporary usage. The type is well preserved and all essential characteristics can be demonstrated e.g. fairly narrow and clamped hyphae, (gloeo-) cystidia and in the subiculum capitate, hyphal ends which are surrounded by yellowish excretions, basidia with two sterigmata, and spores approximately 9-11 x 5-7(-8) um. It should be noted that the similarity to Radulomyces confluens (Fr.) M.P. Christ. mentioned by Pouzar and Liberta is superficial.

SISTOTREMA INTERMEDIUM Hjortst. spec. nov. Fig.1.

Fructificatio resupinata, effusa, adnata, sensim continua, in sicco plus minus rimosa, sub lente levis, obscure tuberculata, colore albido vel dilute ochraceo, margine simili; systema hyphale monomiticum, hyphae basales distinctae, tenuitunicatae vel crassiusculae, plerumque leves vel leviter incrustatae, 3-5 um latae, fibulatae, protoplasmate oloeso, hyphae subhymeniales similes sed cellulis plus minus brevibus; cystidia nulla; basidia urniformia, 30-40 x 6-7 um, 4 sterigmatibus, raro 2-3, sporis (sub-) amygdaliformibus, tenuitunicatis, hyalinis, levibus, generatim 9 x 5 um, variae magnitudinis 8-11 x 4.5-6.5 um.

HOLOTYPUS: Norway. Hedmark. Folldal, Holen near Grimsa, 650 m.a.s.l. on Salix nigricans. 1979-08-25. Leif Ryvarden 18065 (O). ISOTYPUS: in herb. (GB). PARATYPI: Finland. Lapland. Rovaniemi, Pisavaara Nature Park, on branch of Salix sp. 1960-08-30. Viljo Kujala & John Eriksson 9611 (GB). Sweden. Torne Lappmark. Abisko, near Vuolep Njakajaure, on branch of Salix sp. 1960-08-16. John Eriksson 8817 (GB).

Fruitbody resupinate, effuse, adnate, at first porulose, finally continuous, but cracking when dry, smooth or indistinctly tuberculate, whitish to pale ochraceous, margin not differentiated, thinning out. Hyphal system monomitic. Subicular hyphae distinct, forming a thin layer next to the substrate, with thickened walls, straight and uniform, usually smooth but may be slightly encrusted, 3-5 um wide, with clamps, protoplasm filled with oildrops, subhymenial hyphae thin-walled, short-celled in comparision with the basal ones.

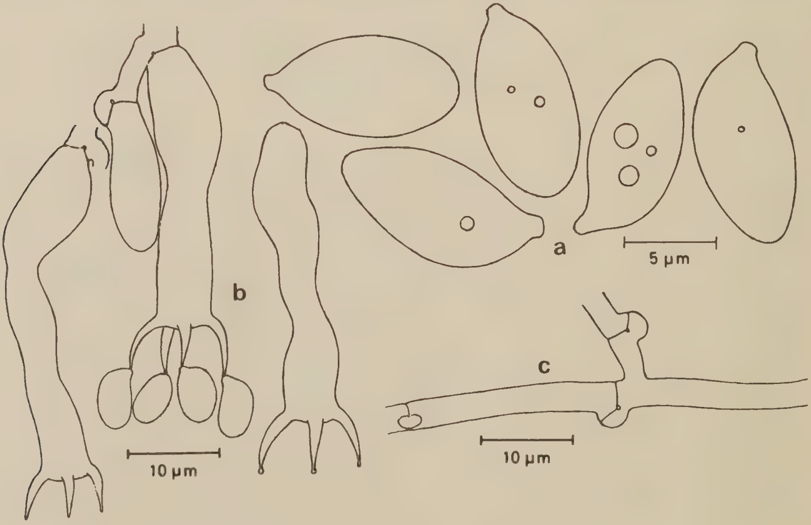

Fig. 1. Sistotrema intermedium a) spores b) basidia c) hypha. — From the type, del. John Eriksson.

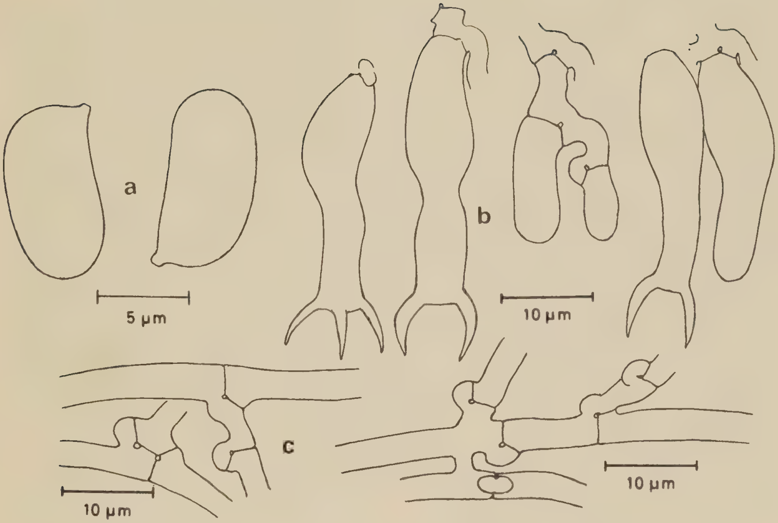

Fig. 2. Sistotrema eximum a) spores b) basidia c) hyphae. —— From the type, del. John Eriksson.

Cystidia absent. Basidia typically urniform, 30-40 x 6-7 um, usually with 4, moderately stout sterigmata, more rarely 2-3. Spores (sub-)amygdaliform, thin-walled, hyaline, smooth and generally 9 x 5 um, but varying in size from 8 to 11 um long and 4.5-6.5 um wide.

This new species is easily recognized by its relatively large and (sub-)amygdaliform spores. It is somewhat intermediate between S. eximum (Jacks.) Ryv.& Solh. and S. autumnale Ryv.& Solh. The latter species is well delimited by its large spores (up to 13-15 um long) and by having basidia with 2, rarely 3(-4) sterigmata. It has also a more loose fructification, at first arachnoid then subpellicular.
The holotype of Corticium eximum Jacks. has been studied and this species is obviously similar to the new species described here but having spores decidedly ellipsoid, neither amygdaliform nor subfusiform (fig.2). Compare Ryvarden and Solheim 1977.

SPHAEROBASIDIUM SUBINVISIBILE Liberta Fig.3.
Mycologia 58(6):931, 1966.

HOLOTYPUS: Canada. Gaspesian Park, (W. Gaspé Co.), on wood of Picea. 1964-06-30. A.E. Liberta 1340 (ISU). The species is presumably known only from the type locality.

Although the holotype is very scanty and the fruitbody barely visible, the fungus is fairly well recognizable under a microscope. Most basidia seen are apparently immature, while

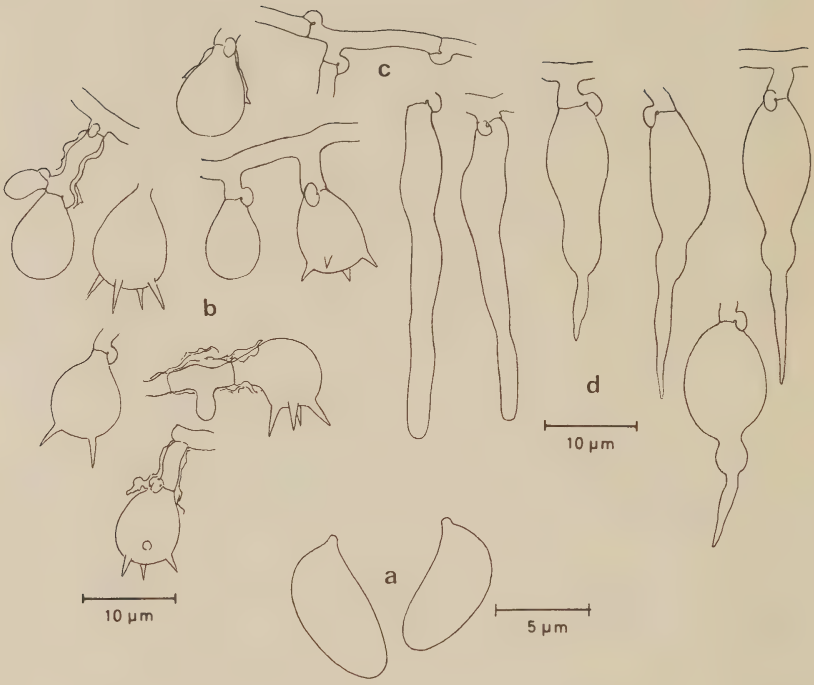

Fig. 3. Sphaerobasidium subinvisibile a) spores b) basidia c) hypha d) cystidia.——From the type, del. John Eriksson.

others (seemingly better developed) are somewhat reminiscent of those of Repetobasidium. The cystidia, which were not mentioned in the original description, point also to that genus e.g. R. vile (Bourd.& Galz.) John Erikss. and to a some extent R. erikssonii Oberw. The presence of such morphological indications are interesting, but as no true basidial-repetition can be demonstrated in the holotype, I prefer to retain the species in Sphaerobasidium. It should be noted, however, that Sphaerobasidium minutum (John Erikss.) Oberw. (generic type) comes fairly close to species of Repetobasidium (see Cort. North Europe Vol.6:1249).

XENASMATELLA CALIFORNICA (Liberta) Hjortst. comb. nov.

BASIONYM: Xenasma californicum Liberta, Mycologia 57(6):967-968, 1965.
HOLOTYPUS: U.S.A. California. Napa Co., Hennessey, on deciduous wood. 1964-12-06. K. Wells 1688 (ISU).

X. californica is closely related to other species in the genus Xenasmatella as interpreted by Oberwinkler (1965). It is quite distinct and particularly reminiscent of X. tulasnelloidea (Höhn.& Litsch.) Oberw. The spores, however, are more elongated but still remind in shape of this species. See also below under X. romellii.

The genus Xenasma Donk (a small part of the xenasmatoid fungi) has been thoroughly treated and also emended by Oberwinkler (1965 and in part 1977). Thus only a few species are now accepted in the genus viz.: X. parvisporum Pouz., X. praeteritum (Jacks.) Donk, X. pruinosum (Pat.) Donk, X. pulverulentum (Litsch.) Donk, and X. rimicolum (Karst.) Donk. A few species described in the genus are outside the scope of the circumscription e.g. X. amylosporum Parm. and X. macrosporum Liberta. The last species seems to fit better in Tubulicium (according to the description) and the former is said to be synonymous with Gloeocystidiellum subasperisporum (Litsch.) Erikss.& Ryv., (see Jülich and Stalpers 1980). Finally, Peniophora subcalcea Litsch. has been excluded by Jülich (1979) and is the type species for Lepidomyces.

The circumscription of Xenasmatella has been variously treated. Jülich (1979) introduce the new genus Aphanobasidium for smooth-spored (both amyloid and inamyloid) species which were formerly placed in Xenasmatella, and Oberwinkler (1977) abandoned the genus and re-established Phlebiella Karst. (generic type Phlebia vaga Fr., Syst.Myc.I,p.428, 1821) for species with warted spores. At the same time he also proposed three new combinations. In his opinion Corticium subflavido-griseum Litsch. (generic type of Xenasmatella)can only be separated from Phlebia vaga at specific level.

In spite of the fact that Ph. vaga has characteristics which come close to those of Corticium subflavido-griseum (hyphal strands, warted spores, and often lateral basidia) I prefer to keep the species separated from the xenasmatoid fungi. The spores, apparently pale brown in the microscope (KOH) and showing a dextrinoid reaction (pale yellowish), might be emphasized as important to its generic position and could equally well be a reason to assigning it to a subgenus of Trechispora or to a genus of its own.

XENASMATELLA GASPESICA (Liberta) Hjortst. comb. nov.

BASIONYM: Xenasma gaspesicum Liberta, Mycologia 58(6):932, 1966.

HOLOTYPUS: Canada. Quebec. Mantana Co., ½ mile S. of Grand Métis, on wood of Picea sp. 1964-06-18. E.E. Liberta 805 (ISU).

This species was described from a single collection but is well characterized by its subfusiform spores (see the original description and Oberwinkler fig.22, 1965).

The Nordic material matches the type specimen quite well but in general the spores are slightly longer, often up to 7-9 (-10) um and with a width of 2-2.5 um. Both basidia and hyphae have approximately the same size and width respectively as described in the protologue by Liberta. It is undoubtedly a good species of Xenasmatella as the genus has been delimited by Oberwinkler (1965). It is interesting to note that the Nordic, and also the Bavarian collections, have been recorded on ferns and herbs. Concerning Oberwink-

ler´s specimen (FO 5600), this has not been studied, but according to the description and the good illustration, it appears to be the same.
It should be mentioned that Karl-Henrik Larsson correctly recognized the species when he found it in Sweden.

ADDITIONAL SPECIMENS STUDIED: Norway. Akershus. Eidsvoll, Mistberget, southern end of lake Tisjøen, 420 m.a.s.l., on Aconitum septentrionale. 1978-09-26. K Hjortstam & KH Larsson, Hjm 10093 (GB). Sweden. Västergötland. V:a Tunhem par., Hunneberg, Storeklev, on Athyrium filix-femina. 1978-09-30. KH Larsson 2350 (GB and ISU); Östergötland. V:a Tollstad par., Omberg, Storpissan state forest reserve, on Dryopteris filix-mas.1980-10-29. K Hjortstam 12556 (GB).

XENASMATELLA ROMELLII Hjortst. spec. nov. Fig.4.

Differt a Xenasmate californico sporis distincte ellipsoideis, prope apiculo haud ventraliter concavis, verrucis saepe ad lineam ordinatis, dorsaliter distincte praesentibus, ventraliter persaepe praesentibus.

In honour of the eminent Swedish mycologist Lars Romell.

HOLOTYPUS: Sweden. Uppland. Ekebyholm, Rimbo, on deciduous wood, probably Corylus. 1917-11-18. L. Romell 3925:2 (S).
ISOTYPUS: in herb. (GB).

Fruitbody resupinate, closely adnate, crustaceous, thin, smooth, more or less ceraceous, in colour greyish with the margin undifferentiated. Hyphal system monomitic. Basal hyphae parallel, closely packed and somewhat agglutinated, thin-walled, hyaline and smooth, 2.5-3.5(-4) um, subhymenial hyphae distinctly irregular, anastomosing, short-celled, all hyphae with clamps, neither amyloid, dextrinoid or cyanophilous. Cystidia absent. Basidia lateral or sublateral, more or less cylindrical, usually 15-20 x 6-7 um, with four sterigmata, 4-7 um long. Spores ellipsoid, more rarely subcylindrical, verrucose, hyaline, dorsally, or at least near the apiculus, smooth or with very inconspicuous warts, often with the warts arranged in ridges, 6.5-7.5 x (3-)3.5(-4) um, non-amyloid.

This new species differs from X. californica in having distinctly ellipsoid spores, with straight ventral side near the apiculus. The spore-ornamentation is often arranged in a characteristic ridged-manner (fig.4,a). It seems to fit well in the sectio Asperulosporum Parm. (type species X. tulasnelloidea). Because of its spore-morphology it is also similar to X. subflavido-grisea, particularly by lack of warts on the proximal-ventral side. Otherwise, it is quite well separated from that species, e.g. by larger basidia and spores.
The single specimen of the described species was found in material from the Stockholm herbarium during the work with Sistotrema for "Corticiaceae of North Europe". It was determined Gloeocystidium coroniferum by V. Litschauer. Already Romell had, as can be seen by his note on the envelope, observed the asperulate spores.It is somewhat remarkable that this characteristic fungus not has been recollected during the past 65 years in the Stockholm area, which is one of the

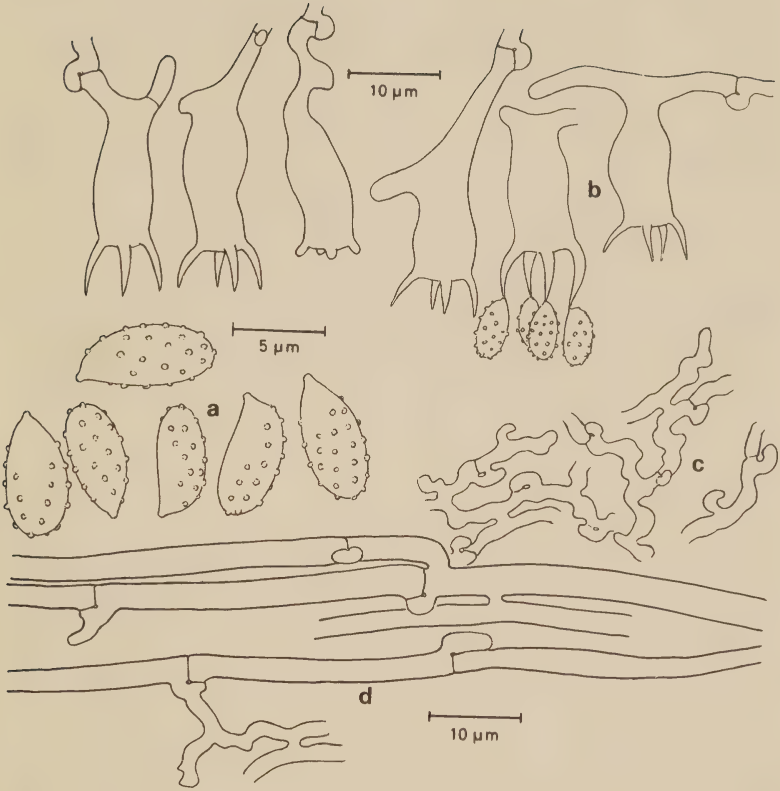

Fig. 4. Xenasmatella romellii a) spores b) basidia c) irregular subhymenial hyphae d) parallel basal hyphae.——From the type, del. John Eriksson.

best studied part of Sweden.

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REVUE DES LIVRES

par

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Belgique*

AN ANNOTATED INDEX TO THE MYCOLOGICAL WRITINGS OF FRANZ PATRAK, Volume 1, A-B, by Gary J. SAMUELS, New Zealand Department of Scientific and Industrial Research Bulletin 230, 240p., 1 phot., 21 x 15 cm, paperback, 1981. Science Information Division, DSIR, P.O.B. 9741, Wellington, N.Z. Price NZ$ 9.50.

Frans Petrak (1886-1973), who worked in Czechoslovakia and Austria, was one of the last of the classical mycologists who were familiar with and wrote about all groups of fungi. Petrak's sixty three years of mycological work are of extreme value to mycology. Particularly concerned with the Ascomycetes and the Coelomycetes, and often in association with Hans Sydow, he published 420 original papers and the famous bibliographical and nomenclatural listing of the fungi for the years 1919 to 1939 published in Just's Botanischer Jahresbericht up to 1935 and later in the CMI Index of Fungi. Petrak also published several important series of exsiccati and deposited thousands of specimens in mycological herbaria. such an annotated index, as taken up by Gary Samuels, will bring together into a single list, alphabetized by generic names, the 20000 names of genera and infrageneric taxa cited or discussed in the Petrak's papers other than the Petrak's list. This volume 1, covering A and B, is the first of a series of about 10 volumes. It provides us with a list of Petrak's papers. The list of fungus names includes the references to the Petrak's papers and exsiccati, the mention of the substrate or host, an indication of the teleomorph or anamorph in Petrak's opinion and annotations about the synomymy or reidentification. The volume is ended by an alphabetical index of the covered specific epithets. When completed, the index will provide the taxonomist with an invaluable tool.

MONOGRAPH OF CROCICREAS (ASCOMYCETES, HELOTIALES, LEOTIACEAE), by Steven E. CARPENTER. The New York Botanical Garden Memoirs 33, 290 p., 48 figs., 8°, paperback, 1981. The NY Botanical Garden, Bronx, NY 10458. Price: $ 35.00.

The type species of *Crocicreas* Fries, *Perisporium gramineum* Fries, is not a representative of the Sphaeropsidales as thought by Fries, but an inoperculate discomycete of the Leotiaceae, in the Helotiales. *Crocicreas* is thus an older name for *Cyathicula* de Notaris and includes 54 taxa now, of which 16 are new. 302 taxa previously assigned to *Allophylaria, Belonioscypha, Cyathicula, Davincia, Phialea* and *Scelobelonium* are discussed on the basis of type material. The correct name or, in 14 cases, a new combination is provided for them. *Crocicreas* is characterized by its stipitate cupulate apothecia and an ectal excipulum composed of long-celled widely spaced hyphae imbedded in a gel, with no sclerotia or stromata. Ascospores may be non-septate or with 1-5 septa. It is closely retated to

Bisporella, Allophylaria and *Stamnaria*. This monograph surely is a good clarification of the taxonomy of these minute discomycetes.

TAXONOMY OF AMAURODERMA (BASIDIOMYCETES, POLYPORACEAE), by João S. FURTADO, The New York Botanical Garden Memoirs 34, 110 p., 41 figs. 8°, paperback, 1981. The NY Botanical Garden, Bronx, NY 10458. Price: $ 17.50.

This revision of the genus *Amauroderma* Murrill is based on a reevaluation of the microsctucture of the basidiocarp, especially the pilear cover (crust, cortex, dermis), hyphal system (generative, skeletal, binding hyphae) and hymenial structures. 140 taxa have been reexamined. 30 are excluded. Through a study of numerous collections, the other taxa proved to be mere variations of each other and are reduced to 27 finally. Two keys are provided: one based on the pilear cover microstructure, the other on the classical micro- and macroscopic characters. The monograph is illustrated by black and white photographs of fruit bodies, cross sections, and basidiospores from the type or other typical material.

BRITISH FUNGUS FLORA. AGARICS AND BOLETI. 3.BOLBITIACEAE: AGROCYBE, BOLBITIUS & CONOCYBE, by R. WATLING, 140 p., 224 figs., 8°, paperb., 1982. Royal Botanic Garden, Edinburgh, Her Majesty's Stationery Office, 13a Castle Street, Edinburgh EH2 3AR, Scotland. Price: £ 8.

This part of the British Fungus Flora is not a complete monograph of the family Bolbitiaceae, but an account on the most widespread species of the three genera *Agrocybe, Bolbitius* and *Conocybe*. The aim of the author is, in this first step, a correct identification and description of a selected number (respectively 17, 5 and 58) of species and an awakening of interest towards those small and neglected brown-spored agarics. The genus *Agrocybe* is divided in two subgenera, subg. *Agrocybe* and *Aporus,* 6 sections and 9 stirps. *Bolbitius* is divided in two subgenera, subg. *Bolbitius* and *Pluteolus*. The 58 species of *Conocybe* are disposed in 5 subgenera, subg. *Conocybe, Ochromarasmius, Galerella, Piliferae* and *Pholiotina,* 9 sections and 29 stirps. Line drawings illustrate every species. The species *Conocybe leucopus* and *C. anthracophila* are described with reference to unpublished Latin diagnoses; their names are thus nomina nuda in this paper. Neither the type material nor the collections examined are listed after the descriptions.

EXOBASIDIUM, A TAXONOMIC REASSESSMENT APPLIED TO THE EUROPEAN SPECIES, by J. A. NANNFELDT, Symbolae Botanicae Upsalienses 23:2, 72 p., 8 figs., 8°, paperback, 1981. Almquist & Wiksell International, Stockholm, Sweden.

Criteria of taxonomic interest in *Exobasidium* are reviewed by Prof. J. A. Nannfeldt with a special attention on symptoms and life cycles. A distinction is made between *monocarpic* life cycle with mycelium fruiting only once and *polycarpic* life cycle with perennial mycelium forming basidia year after year. The genus taxonomy is therefore completely revised. Host races known from Europe are raised to specific rank and the number of European species becomes 27, including 1 new combination and 10 new epithets. Three additional species are found on European hosts but outside Europe. *Gloeosporium exobasidioides* Juel is found to be part of the life cycle of *Exobasidium sydowianum*. The distribution of each species is given with references, lists of exsiccati and maps for Fennoscandia. The frontispiece is a pretty color photograph of 6 *Exobasidium* species.

THE FAMILIES OF BITUNICATE ASCOMYCETES, by Ove ERIKSSON, Opera Botanica n° 60, 220 p., 240 figs., 8°, paperback, 1981. Nordic Publications in Botany,Dr. Morton Lange ed., Ø Farimagsgade 2D, DK-1353 Copenhagen K, Denmark.

In this large monographic work the author discuss the morphology and the nomenclature of 195 families of bitunicate or alleged by bitunicate ascomycetes. For 73 species representatives of these families, morphological features of asci, ascospores and ascomata have been observed and illustrated under the SEM. For each family, the type and the circumscription are indicated, drawings and photographs of the ultimate type species are provided. Anamorphs, when known, are also mentioned, Two families, the Coccodiniaceae and Microtheliopsidaceae, one genus, *Amarenomyces,* and one species, *Euantennaria abietina,* are new. Meaningful opinions on a possible stratigraphic or phylogenetic scheme of classification of the Ascomycetes are followed by the proposition of an eclectic, non speculative, transitory classification of the Ascomycetes, comprising 109 monophyletic entities. A fine reference work.

GUIDE PRATIQUE DE MYCOLOGIE MEDICALE ET VETERINAIRE, by R. VANBREUSEGHEM, Ch. DE VROEY and M. TAKASHIO, 2d edition, 264 p., 571 phot., 8°, hard cover, 1978. Ed. Masson, 120 Bd. St. Germain, F-75280 Paris 6, and 14 East 60th street, New York, NY 10022.

Prof. R. Vanbreuseghem associated himself with his closest collaborators, Prof. Ch. De Vroey and Dr. vet. Md. M. Takashio, in the revision and completion of the first edition of his Guide published in 1965. The text part comprises (Part 1) the description of mycoses and pseudomycoses and (Part 3) the microscopical, histological and cultural technics in the study of pathogenic fungi. Part 2 gives an illustrated description of each pathogenic fungus and od some actinomycetes. The iconography of 571 black and white photographs includes 211 replaced or newly added ones. To be noticed : the segragation of *Microides interdigitalis, M. mentagrophytes, M. persicolor* and *Trichophyton simii* from the complex *Trichophyton mentagrophytes*; the addition of *Trichophyton soudanense, Hendersonula toruloidea, Scopulariopsis brevicaulis* and *Saprolegnia ferax*; the synonymy of *Trichophyton ferrugineum* to *Microsprum ferrugineum*, of *Trichosporon geigelii* to *T. cutaneum*, of *Malassezia furfur* to *Pityrosporum orbiculare*. But *Acremonium falciforme, A. recifei* and *A. potronii* are still (incorrectly) named *Cephalosporium*. The disease name moniliasis is now replaced by that of candidosis. This new edition surely, like the first one, will be a succes. It is the only guide of such value in the French language.

SIMON & SCHUSTER'S guide to mushrooms (original title FUNGHI), by Giovanni PACIONI, 512 p., 420 col. Phot., 11.5 x 19 cm, paperback, translated from Italian and ed. Gary H. LINCOFF, (1980) 1981. Publ. Simon & Schuster, Rockfeller Center, 1230 Ave. of the Americas, New York, NY 10020.

420 species of fungi, Basidiomycetes mostly, are very well illustrated in this pocket book. The descriptions face the plates, are headed with the Latin name and accompanied by three color symbols for spore color (4 categories), edibility (5 categories), and ecological behaviour (mycorrhizal, parasitic, saprophytic). Comments are made on the fungus distribution when restricted. A foreword explains what the fungi are, their ecology, growth, cultivation, toxicity, edibility and how to study them. The genera are distributed in 10 keyed groups according the shape of

the fruitbodies and structure of the hymenium. The gilled mushrooms are subdivided according the color of the spores. This may proove to be a good field guide for beginners.

THE AUDUBON SOCIETY FIELD GUIDE TO NORTH AMERICAN MUSHROOMS, by Gary H. LINCOFF, 928 p., 762 col. Ph., 10 x 19.5 cm, plastic cover, 1981. Publ. Alfred A. Knopf inc., 201 East 50th Street, New York, NY 10022. Price: $ 12.50.

This is another field guide. 762 good color photographs of fungi, Basidiomycetes mostly, are presented together in one part on black backgrounds strong paper, followed by descriptions printed on flimsy bible paper. The illustrations of the species are disposed in 14 groups and 72 subgroups, visually keyed by white on black outlines of the fruitbodies, They are thus not in a taxonomical order: the cup shaped fuitbodies, for example, groups both Ascomycetes and Basidiomycetes; the bird nest fungi and *Cantharellus* species are scattered in three different groups. The illustrations are subtitled with an English common name only with notation of the page of the description. The descriptions are in a taxonomical order, headed with both English and Latin names and followed by comments on related but not illustrated species. A number refers to the illustration. A synoptic key base on spore color, gill attachment, veil and habitat is supplemented. The grouping in different sequences of the illustrations in one part and of the descriptions in another part makes the comparison of one to the other very difficult. Further the Latin name should have been printed under the photographs as well. The guide is compact and of a handy size. Although some illustrations are quite dark, this guide might be of interest by virtue of the large number of species covered.

MUSHROOMS & TOADSTOLLS: A COLOR FIELD GUIDE, by U. NONIS (original tit. FUNGHI A COLPO D'OCCHIO), 230 p., 168 color ph., 13 x 21 cm, hard Cover, (ed. Priuli et Verlucca, 1981), translated from Italian, 1982. Publ. David & Charles Ltd., Newton Abbot, London. Price: £6.95.

Yet another field guide. This one illustrates 168 species of fungi. Each illustration is brought together with its Latin name, a short description and a synoptic table of 104 symbols showing in yellow those characterizing the species. The species are arrange according the main color of the fruit body which is indicated on the top corner of each page. The symbols listed in the introduction represent the characters of Agaricales mostly and are useless in other groups. Some symbols do not show the character clearly. The symbols 58 and 59 are inversed: 58 represents free gills and 59 adnexed gills. They are two symbols for "gilled" and for "tubular" hymenium: it was therefore unnecessary to symbolize each of those kinds of hymenium as free, adnate, decurrent and decurrent with fillet; four entries could have been saved. The stipe represented by symbols 71 to 75 should have been called "central". The symbols 78, 79, 83 and 86 should have been grouped as representing the ornementation of the stipe. Edibility is not a key character and should not be included. The character of stipe fasciculation is not symbolized. Nor are the arbuscular, filiform or globose fruitbodies. The descriptions are very short and without comments. The guide might seem attractive to use, but it appears difficult. The symbolic tables are more a kind of description than an efficient synoptic key. There is no other key in the book. The very strong paper and cover also make this field guide impractical.

ETNOMICOLOGIA PUREPECHA. El Conocimiento y Uso de los Hongos en la Cuenca de Påtzuaro, Michoacån, by Cristina MAPES, Gaston GUZMAN & Javier CABALLERO, Serie Etnociencia, Cuardenos de Etnobiologia n° 2, 80 p., 2 pl., 4°, paperback, 1981. Sociedad Mexicana de Micologia, Ap. post. 26-378, Mexico 16, D.F. Mexico.

Research results on the knowledge of mushrooms by the Purepecha people in the Basin of the Lake Påtzcuaro, state of Michoacån, Mexico, are presented. Off the 600 specimens collected representing 134 species of Basidiomycetes, Ascomycetes, Deuteromycetes, Myxomycetes and some Lichens, 99 have a popular name, 53 in the Purepecha language. 43 species are used as edible, 5 (*Ustilago maidis* and 4 lichenes) used as medicinal and 20 recognized as poisonous. *Psilocybe mexicana, P. cubensis* and *Amanita muscaria* are known to be hallucinogenic.

DOCUMENTS DE TRAVAUX DIRIGES. LICHENS, by E. KIFFER and M. JACQUEMIN, 42 p., ill., 4°, mimeograph., 1982. University of Nancy, France.

This is a condensed outlines of lectures on lichens taught at the University of Nancy. It covers the anatomy, morphology, organography of the lichens and of their partners, their classification and an identification key to about 60 species.

REPRINTS OF MYCOLOGICAL CLASSICS PROPOSED

The firm of JOACHIM SCHLIEMANN, Ballindam 35, 2 Hamburg 1, West Germany is considering reprinting three mycological classics if there is enough interest on the part of the mycological public.

Should you or your institutional library be interested in acquiring one or more of these, it would probably be to your advantage to contact the publisher with this information.

The three works proposed for reprinting are:

FRIES, E. M. 1860-1866. Sveriges atlige och giftiga svampar.

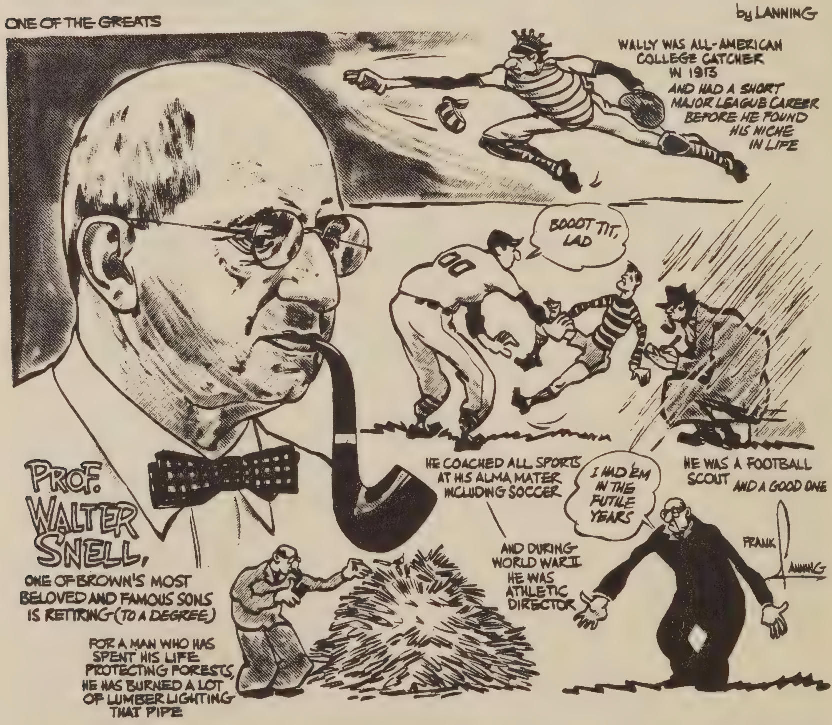
FRIES, E. M. 1867-1884. Icones selectae Hymenomycetum nondum delineatorum. 2 vols.

SCHAEFFER, J. C. 1762-1764. Fungorum qui in Bavaria et Palatinatu .... 4 vols.

Extra:

GENTLEMEN UNDER THE ELMS, by Jay Barry, 176 p., ill., 4°, hard cover, 1982. Publ. Brown Alumni Monthly, Brown University, Box 1854, Providence, RI 02912, USA.

A tribute to eleven of Brown's Faculty of the past (1920–1980) invoking, with style and humour, the memories, "the sweet without the bitter", of these gentlemen teaching under the elms of the Brown's campus in Rhode Island. Amongst them, a professor in botany, also a mycologist of international recognition, Walter H. Snell, familiarly named Wally. The *Glossary of Mycology* is well known, that he published in 1957 with his associate Esther Dick, later Mrs Snell. Let us also remember that mycology, especially *the Boleti of north-eastern North America* (1975), was a field that he loved so much, as he did water color painting, instrumental music, athletics and ... his pipe.


ONE OF THE GREATS
by LANNING
WALLY WAS ALL-AMERICAN COLLEGE CATCHER IN 1913
AND HAD A SHORT MAJOR LEAGUE CAREER BEFORE HE FOUND HIS NICHE IN LIFE
BOOOT TIT, LAD
PROF. WALTER SNELL,
ONE OF BROWN'S MOST BELOVED AND FAMOUS SONS IS RETIRING (TO A DEGREE)
HE COACHED ALL SPORTS AT HIS ALMA MATER INCLUDING SOCCER
I HAD 'EM IN THE FUTILE YEARS
HE WAS A FOOTBALL SCOUT
AND A GOOD ONE
AND DURING WORLD WAR II HE WAS ATHLETIC DIRECTOR
FRANK LANNING
FOR A MAN WHO HAS SPENT HIS LIFE PROTECTING FORESTS, HE HAS BURNED A LOT OF LUMBER LIGHTING THAT PIPE

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NOTICE

TO PROSPECTIVE AUTHORS

Beginning with manuscripts accepted for volume 18 of MYCOTAXON it will now be possible for authors to obtain **offprints** instead of or in addition to **reprints** of their articles.

All articles will now begin with a right-hand page, to facilitate production of offprints without extraneous matter. A consequence is that there will now be some few blank pages in the journal.

An advantage of offprints is that they will be available three to eight weeks sooner than reprints, since they are produced during the press run. All offprints will be side-stapled. A disadvantage of offprints is that the exact date of publication will not be imprinted on them (though of course authors can stamp this information on offprints prior to distribution). In most cases the cost of offprints will be substantially lower than for reprints.

Reprints will continue to be available, and these will carry the exact date of publication. These will be center-stapled.

Authors who prefer not to have either offprints or reprints produced by our printers will still receive their photo-offset negatives and appropriate cover copy at the close of the press run. These can be used for the production of reprints by a local printer (but the printer should be capable to handling halftones with 150-line screens, if the paper contains such).

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ERRATA, VOLUME FIFTEEN

Page 255,	line 1:	*for* Fig.1 *read* Fig.A
257	1:	*for* Fig.2 *read* Fig.1
259	1:	*for* Fig.3 *read* Fig.2
456	12:	*for* D. nigripes *read* Didymium nigripes

ERRATA, VOLUME SIXTEEN

Page 343,	line 27:	*for* Prior to 1959 *read* Between 1910 and 1950
	39-42:	*see* major correction, MYCOTAXON 17: 573-574.
561	:	illustration was printed upside down

ERRATA, VOLUME SEVENTEEN

Page 121,	line 13:	*for* RHIZINIA *read* RHIZINA
143	5:	*for* RHIZINIA *read* RHIZINA
149	40:	*for* 1945a) *read* 1905a)
267	24:	for *macrospora* read *macrosporum*
298	19:	for (*S.* read (*Selenozyma*
357	21:	for *penzigi* read *penzigii*
534	17:	for *verruculosa* read *verruculosis*
536	16:	for *verruculosa* read *verruculosis*
571	9:	for *C.* read *Cylindrobasidium*

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